PUBLIC EDUCATION MATERIALS:
WELLHEAD PROTECTION

The Great Water Hook-Up

Grades 7-12

➤ **Objectives**

- Build a model of a water-delivery system from source to user.
- Explore factors that need to be considered when designing a water distribution system.

➤ **Interdisciplinary Skills**

Science, Social Studies, Mathematics, Economics

➤ **Estimated Time**

2 hours (may be spread over 2 days)

➤ **Materials**

- ☐ Activity handout
- ☐ Large-diameter cardboard tubes (e.g., map tubes)*
- ☐ Medium-diameter cardboard tubes (e.g., wrapping paper tubes, toilet paper tubes, paper towel tubes)*
- ☐ Small-diameter tubes (rolled card stock or straws)*
- ☐ Ten boxes labeled: school (1 box); business (3 boxes); hospital (1 box); industry (2 boxes); new school (1 box); new business (1 box); new industry (1 box)

* *If tubes are unavailable, roll up poster board or construction paper into different sizes. Tape or staple ends together.*

Teaching Strategy

1. Label boxes before class begins. (Suggestion: A few weeks before you begin the project, ask the students to collect cardboard tubes and boxes for the water distribution system.)
2. Distribute copies of the activity handout. Tell the students that they are water system designers. They have been asked to go to Small Town, New England, to design a new public water supply system. They must decide how to link all the homes and businesses to the water source so that everyone can get the water they need.
3. Have the class work as a group to design the delivery system. At random, give seven students the seven boxes that are labeled "school," "business," "industry," and "hospital." Wherever the students place the boxes will be their location in Small Town, New England. Assume that the chairs or desks in the classroom represent homes. (Reserve the 3 boxes that represent new buildings.)
4. Randomly select a location for the well. (This will be the starting point for the model.)
5. To avoid chaos, provide a large pipe that leads from the well. Have students begin building the distribution system from that point.
6. After the system is designed, have students determine the cost of the entire delivery system.
7. Have students scrutinize the design to see if any changes can be made to reduce the cost. Ask students to calculate the amount of money saved as a result of any design changes.
8. Randomly distribute the boxes marked "new school," "new business," and "new industry." If necessary, redesign the water system, and determine the cost of adding in these new users. Tell students that before a large water user is added to the system, communities must check to be sure there is adequate water to serve them.

Predicting Ground Water Flow

Grades 9-11

➤ Objectives

- Be able to draw a ground water contour map.
- Have a basic understanding of how to predict the direction of ground water flow.
- Understand the interrelated nature of ground water and surface water flow.

➤ Interdisciplinary Skills

Science, Math

➤ Estimated Time

45 minutes

➤ Materials

❑ Activity handout

Teaching Strategy

Through the handout, students will learn how to draw ground water contours and will understand how ground water flow may be predicted. A teacher's copy of the correct ground water contour map is included with this activity. Be sure students have read "Getting Up to Speed" for this section and are familiar with the material in the activity "Revealing Stories—Resource Maps Tell All."

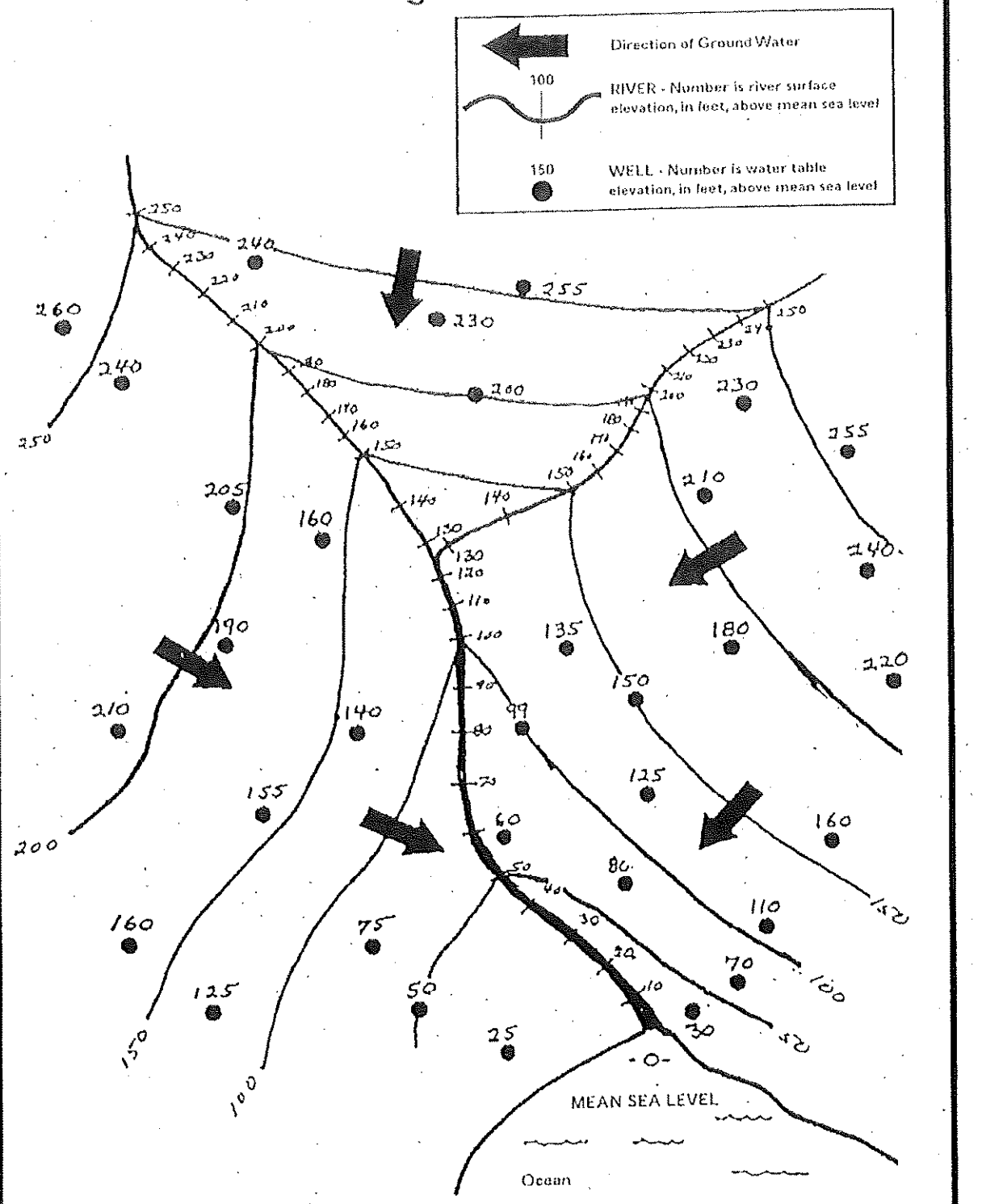
1. Distribute copies of the handout to each student.
2. Either lead students through the exercise as a class activity, or divide the students into teams to complete the assignment.

Follow-up Questions

1. Why should communities be aware of the direction of ground water flow? *By knowing the direction of ground water flow, communities can map out the land area that recharges their public water supply wells, streams, rivers, lakes, or estuaries and thereby take steps to ensure that land use activities in the recharge area will not pose a threat to the quality of the ground water and the resources dependent on it. Since contaminants generally move in the direction of ground water flow, communities can also predict how contaminants might move through the local ground water system.*
2. Why is it important to know if a stream in your community is a "gaining" stream or a "losing" stream? *Gaining streams receive much of their water from ground water, and the water level in the stream is generally at the same elevation as the water table in the adjacent aquifer. Water quality in the stream will be affected by the quality of ground water entering the stream. Because the water table elevation is approximately the same as the gaining stream surface elevation, both elevations may be used to construct water table maps and to predict ground water flow direction.*

   Losing streams lose water to the adjacent aquifer because the water table has dropped below the stream level. If there is no major source of upstream flow, the stream may dry up between storm events.

Contouring the Water Table



Predicting Ground Water Flow

NOTE: Read this entire handout before beginning the activity.

▶ Background

The water table is the surface of the saturated zone, below which all soil pores or rock fractures are filled with water. Ground water moves through the subsurface much like water on the ground surface, except that it travels a great deal more slowly. If the soil is mostly sand and gravel, ground water can move as much as five feet per day. But, more often than not, ground water moves at speeds of a few inches per day (or less).

Like streams and rivers, ground water moves from high areas to low areas. In this exercise, you will draw the contours of the water table to show how ground water moves beneath the ground, down the sides of a valley, to a river that flows to the sea. Before you begin this exercise, however, it is important that you understand three main principles.

First, ground water and surface water share a strong connection in New England. Have you ever noticed that streams continue to flow even when it hasn't rained for days? Where does the water come from? In most areas of New England, water is discharged to surface waters from ground water at the point where the water table intersects the surface of the land. In this situation, the surface water is called a gaining stream or gaining pond.

Second, because the water table is at the land surface adjacent to "gaining" surface waters, the elevation of ground water is generally the same as that of the river, especially between rain storms.

Third, ground water is assumed to flow at right angles to water table contours. This is because ground water moves downhill in the path of least resistance due to gravity. In this exercise, you'll use all three of these principles.

During this activity you will learn how to draw a water table contour map. Water table measurements that are taken at the same time of year can be used to develop a water table contour map to show the direction of ground water flow. Monitoring wells are typically used to determine the elevation of the water table. The elevation of the water table is determined at several locations throughout the area of interest. Like topographic map contours, water table contours represent lines of equal elevation. The difference between the maps is that water table elevations are measured in wells and at the river channel, not on the ground surface. Thus, just as surface water flow is downhill and perpendicular to topographic contours, the direction of ground water flow is also downhill and perpendicular to the water table contours.

Don't worry—drawing contours is easier than you think. Just follow these simple steps:

Directions

ASSIGNMENT

1. Using the "Contouring the Water Table" worksheet, take a pencil (in case you make mistakes), and *lightly* draw in 3 or 4 arrows to show your prediction for the direction(s) of ground water flow.

2. Draw contours at 50-foot intervals. The pencil lines can always be inked-in later. Begin at 50 feet (the shoreline along the ocean will be sea level), then draw the other contours for 100, 150, 200, and 250 feet.

3. To get started, draw the 50-foot contour. Find the 50-foot elevation on the river. Draw a line from that point through the 50-foot elevation at the well just southwest of the river. Don't go much past the well, because there are no more data to tell you where to go!

4. Draw the contour on the other side of the river. When locating a contour between two points, you will have to interpolate—that is, figure out the proportional distance between the points. The 50-foot contour between the 30- and 80-foot elevations should be drawn closer to the 30-foot value (20 feet difference) than the 80-foot value (30 feet difference). You can do this by hand after a little practice, or measure it precisely with a ruler and calculator. For the other two wells, draw the contour exactly between the 30- and 70-foot elevations, because they are both 20 feet different from the 50-foot contour's value.

5. When you are finished, you will notice that the contours form V's with the river and its tributaries. That's because the river is a "gaining" river. It is receiving recharge from the aquifer. The contours show that ground water is moving down the sides of the valley and into the river channel. The opposite of a gaining stream is a "losing" stream. It arises when the water table at the stream channel is lower than the stream's elevation, or stage, and stream water flows downward through the channel to the water table. This is very common in dryer regions of the Southwest. In the case of a losing stream, the V will point downstream, instead of upstream.

NOTE: When making a water table map, it's important that your well and stream elevations are accurate. All elevations should be referenced to a standard datum, such as mean sea level. This means that all elevations are either above or below the standard datum (e.g., 50 feet above mean sea level datum). It's also very important to measure all of the water table elevations within a short period of time, such as one day, so that you have a "snapshot" of what's going on. Because the water table rises and falls over time, your map will be more accurate if readings are made before these changes occur.

Understanding how ground water flows is important when you want to know where to drill a well for a water supply, to estimate a well's recharge area, or to predict the direction contamination is likely to take once it reaches the water table. Water table contouring can help you do all these things!

Follow-up Questions

1. Why are communities interested in learning the direction of ground water flow?

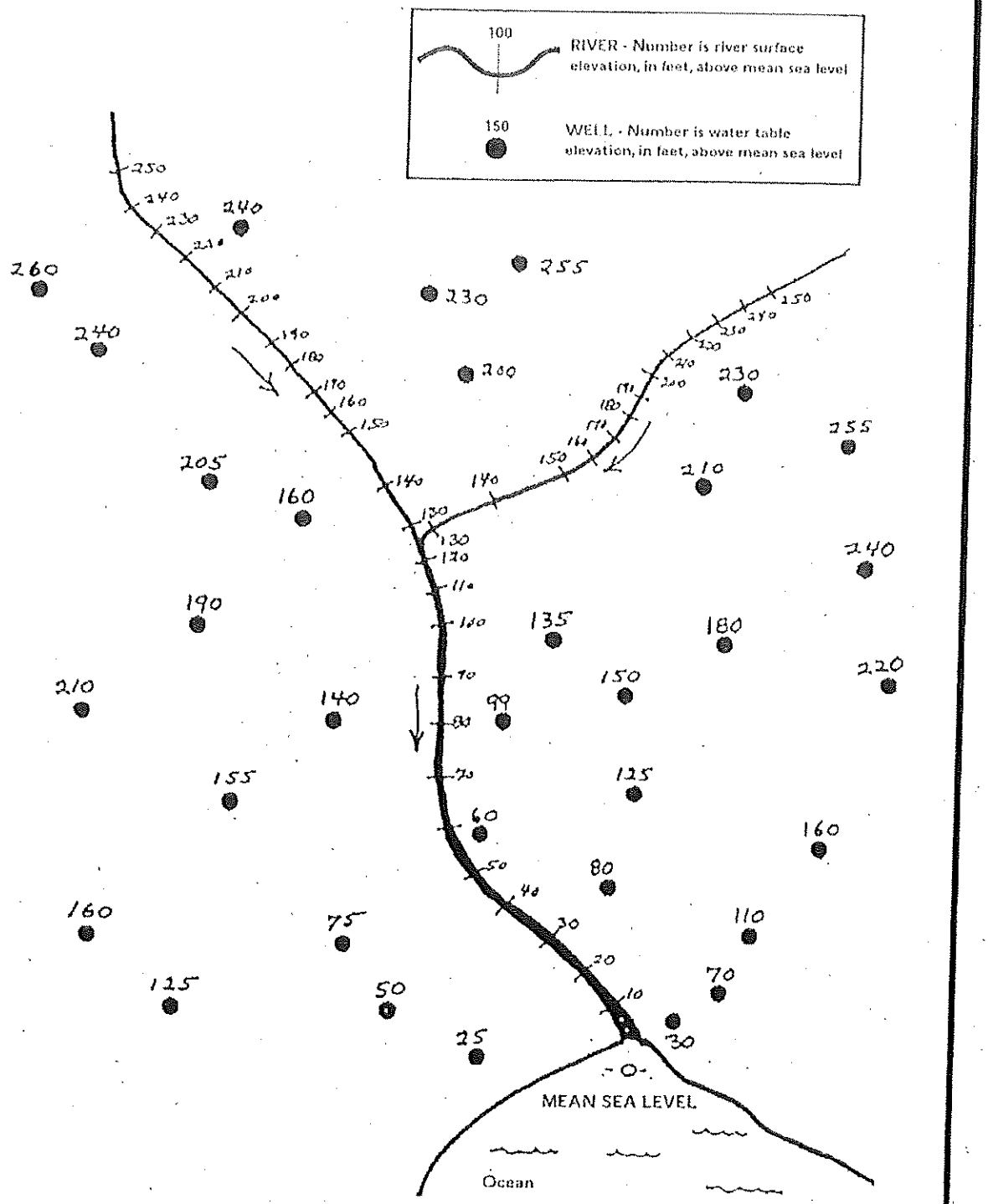
2. Why would it be important to know if a stream in your community is a "gaining" stream or "losing" stream?

3. Compare and contrast your predictions for ground water flow to your mapped ground water flow direction(s). Briefly explain and differences.

KEY TERMS

- Gaining Stream/Pond
- Interpolate
- Losing Stream/Pond

Contouring the Water Table



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9. After designing the water distribution system, help students develop a list of questions that community leaders should ask when designing a system. For example: How many homes, industries, schools, etc. must receive water? How much water do they need? How much water is available? Where will all the homes, businesses, industries, etc. be located? What will the system cost, and how will the community pay for it? How will the community change in the future? How can the community plan for these changes, and in the case of new industries, businesses, and schools, who should pay the costs?
10. Ask students what steps community leaders might take to reduce future costs (e.g., group similar types of users together [zoning], limit growth of the community).

NOTE: If this activity requires more than one class period, have students sketch the system at the end of each class and reassemble it when the class meets again.

Supplementary Activities

- Once the water distribution system is designed, discuss, as a class, how the community will pay for the system (e.g., loan, bond, one-time fee). Calculate the cost of the system for each user (assume the number of students in the class is the number of users), based on current interest rates (if appropriate). Negotiate a payment plan that is agreeable to your "water users." (This activity can used as a math/economics supplement.)
- If your community uses public water, have students research the water distribution system. Obtain a copy of the community's water distribution map(s) and invite your water supplier to come to class and discuss system planning, maintenance, and repair.
- Have the class add a wastewater collection system. Explain that Small Town is having problems with its septic systems and will soon need to build a wastewater treatment plant so that a wastewater collection (sewer) system can be hooked up to all the homes and businesses. Have students find a location where the wastewater can be treated and then discharged into a receiving river or stream. Figure out how to accomplish this great wastewater hook-up.
- Instead of using the piping costs provided in Part 2, relate the cost of the distribution system to the length of the system. To do this, have the students assign an overall scale to the piping system (for example, 1 inch = 10 feet). Based on this scale, assign a cost per linear foot of pipe (for example., $100 per foot (large), $50 per foot

NOTES

(medium), $25 per foot (small). You may even want to break it down further into separate installation and material costs. (Installation costs will be approximately the same per foot, whereas the larger pipe sizes will affect the materials cost per foot.) Have the students measure their proposed distribution system and then convert their results into feet and then into dollars.

Explain to the students that this is how real world construction costs are estimated. This type of exercise will help the students understand scales and conversions and, at the same time, add a planning component to the activity (e.g., the cost of developing away from the town center).

This activity is adapted from Massachusetts Water Resource Authority. *Water Wizards*. Boston: Massachusetts Water Resource Authority.

The Great Water Hook-Up

Background Information

Our drinking water comes from either ground water wells or surface water (e.g., river, lake, man-made reservoir). Ground water supplies are usually extracted by a pump, treated and disinfected when necessary, and delivered to homes and businesses through a network of pipes called a distribution system. Many people who live in rural areas have individual, on-site ground water wells with very simple piping systems; many other people who depend on ground water, but live in more populated areas, receive their water from large water supply wells through more complicated distribution systems.

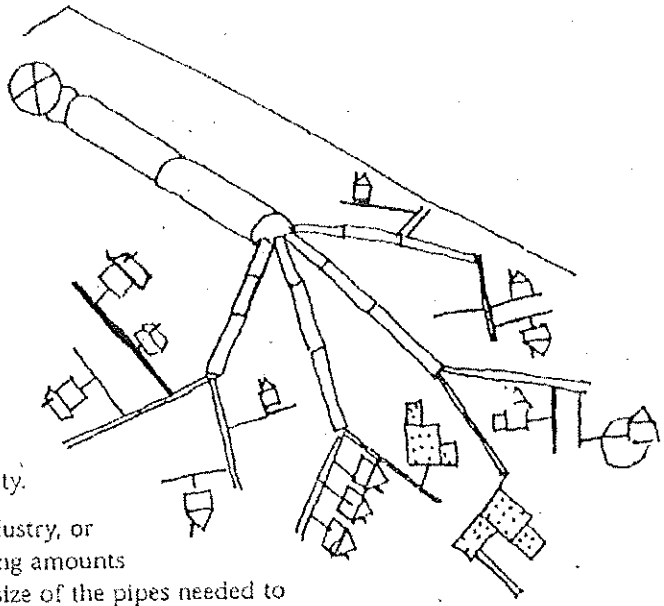
Surface water supplies are withdrawn from rivers, lakes, and reservoirs through large intake structures. The water is disinfected and often treated or filtered to remove impurities before entering the distribution system. Surface water supplies often travel through many miles of underground pipes before reaching the faucets of people's homes and businesses.

In the water distribution system, the size of the pipe is a function of the amount of water that will typically pass through it. Thus, the largest pipe hooks into the source water supply (e.g., ground water well, reservoir, river); middle-size pipes serve larger water users (e.g., office buildings, hospitals, apartment buildings); and the smallest pipes serve individual residences.

PART 1

Scenario

Small Town, New England needs help in designing a new water delivery system. It has asked your firm, Water Hook-Ups, Inc., to do the design work.



Job Specifications

- The community relies on a large well to provide water to its residents, businesses, and institutions and needs a system to pump and deliver water from the well throughout the community.
- Each home, business, industry, or institution requires varying amounts of water. Therefore, the size of the pipes needed to provide water also varies. (Larger pipes provide more water.)

- You must follow these rules when laying pipes:

1. Large pipes must hook up to the well. Large pipes will be used for the major water lines running through the community.
2. The hospital and the industry use a very large amount of water and must be connected to a large water pipe or be served by a couple of medium-size pipes.
3. The businesses and school use a lot of water but not as much as the hospital and industry. They must be connected to a medium-size pipe.
4. Homes use less water than businesses and require a small pipe.
5. Pipes can be connected only in descending order. That is, from the well, large pipes are connected to medium-size pipes, which are connected to small pipes. Also, from the well, large pipes can be connected to small pipes. However, once you lay a small pipe, you cannot add a medium-size pipe or large pipe on the end. That would cause a bottleneck.
6. A large pipe can serve 3 medium-size pipes or 15 small pipes. Each medium-size pipe can serve 5 small pipes.
7. Consider the need for future maintenance and repairs. If a section of pipe must be closed for maintenance, consider how you will provide water to the affected users (e.g., a loop versus a dead-end system).

Part 2: Your Job

ASSIGNMENT

1. Connect the pipes! Be sure that every home, business, industry, school, and hospital will receive water.
2. When you are done laying pipes, determine the cost of the project based on the following cost figures:

   Large pipe = $15,000 each
   Medium pipe = $ 5,000 each
   Small pipe = $ 1,000 each

▶ Follow-up Questions

- How much did the whole delivery system cost?

$ _____

Part 3: Delivery System Changes

1. Look at the delivery system you designed. Can you make any design changes to reduce the cost?

   a. If so, briefly list those changes.

   _____

   _____

   b. What is the cost of the redesigned system?

   $ _____

   c. How much did you save

   $ _____

2. Help! Small Town is growing rapidly. The town wants to build a new school, a new business, and a new industry. (Your teacher will tell you where they are located.) Make changes in your design to serve these new needs.

   a. How much did the changes cost?

   $ _____

   b. Who do you think should pay for those changes? Support your reasoning.

   _____

   _____

   _____

   _____

KEY TERMS

- Distribution System
- Drinking Water

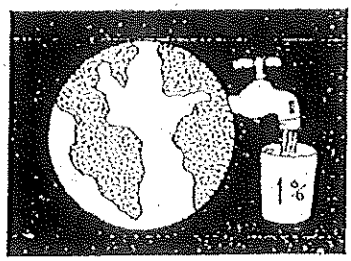
This activity is adapted from Massachusetts Water Resource Authority. *Water Wizards*, Boston: Massachusetts Water Resource Authority

United States
Environmental Protection
Agency

Office of Water
Washington, D.C. 20460
EPA 570/9-91-100

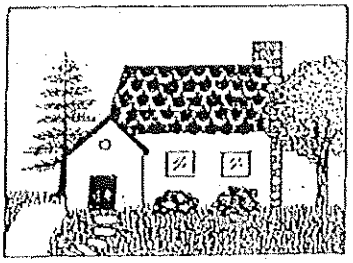
EPA

Fact Sheet: 21 Water Conservation Measures for Everybody



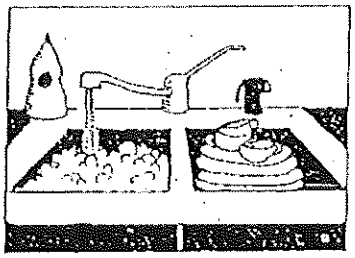
The earth is covered with water, yet only one percent is available for drinking. Unfortunately, many of us take this small percentage for granted. The average adult needs only 2-1/2 quarts of water per day to maintain health, but in the United States, we each use 125 to 150 gallons per day for cooking, washing, flushing, and watering. That's over 40 percent more water than we need to accomplish these tasks. Our wasteful habits not only deplete clean water reserves faster than we can replenish them, but they pollute many waterways, rendering them unfit for human consumption. They also stress aging drinking water and sewage treatment facilities beyond their capacities. In each of the past few years, wastewater treatment systems dumped an estimated 2.3 trillion gallons of inadequately treated sewage into U.S. coastal waters, destroying beaches, fisheries, and other marine life.*

We waste water both by practicing bad habits, like leaving the water running when we brush our teeth, and by using antiquated equipment not built with water conservation in mind. Bad habits can be difficult to change, but new ones can save thousands of gallons of water per year per person. Installing new water-saving equipment and small devices also can save significant amounts of water per household without requiring us to change our daily routines. Many devices are inexpensive, available in local hardware stores, and easy to install. They can save energy (and energy bills) too! By following a few simple steps, a typical family of four can save an astounding 50,000 to 100,000 gallons of water per year. What are we waiting for?



For Every Room in the House

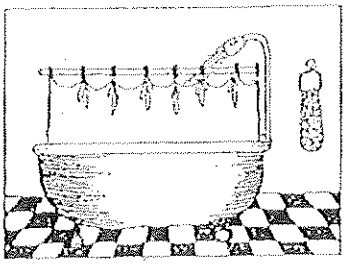
- Repair leaky faucets, indoors and out. One leaky faucet can use up to 4,000 gallons of water per month.
- Install faucet aerators. These inexpensive devices can reduce water use up to 60 percent, while maintaining a strong flow.



In the Kitchen

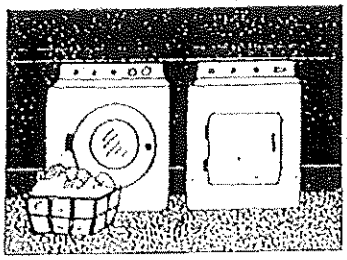
- When cooking, save 10 to 15 gallons of water per meal by peeling and cleaning vegetables in a large bowl of water instead of under the running tap.
- When handwashing dishes, save 15 gallons of water by soaking dirty dishes in the basin, then rinsing them off.
- Run full-load dishwashers to save 15 gallons per load and hot water costs, too.
- When buying a new dishwasher, select one with a "light-wash" option. Newer models use 20 percent less water than older ones.

*Congress of the United States, Office of Technology Assessment, 1987. Waste in the Marine Environment, Washington, D.C.



In the Bathroom

- Take short showers instead of baths. Showers use an average of 5 to 7 gallons per minute, three times less than the water used to take a bath.
- Install a low-flow showerhead. This will cut water use in the shower to just 3 gallons per minute and still provide an invigorating flow.
- Turn off the water to brush teeth, shave, and soap up in the shower. Filling the sink to shave uses only 1 gallon, while letting the water run can use 10 gallons per shave or more. Turning off the water when you brush your teeth can save 4 gallons of water each time.
- Repair leaky toilets to save more than 50 gallons of water per day. Add 12 drops of food coloring into the tank. If color appears in the bowl one hour later, the unit is leaking.
- Install a toilet displacement device to save thousands of gallons of water per year or 5 to 7 gallons per flush. Place one to three weighted plastic jugs into the tank, making sure the jugs don't interfere with the flushing mechanism or a suitable flow. Or, instead of jugs, use toilet dams that hold back a reservoir of water during each flush, saving 1 to 2 gallons. Don't use bricks because they can chip and foul the flushing mechanism.
- When buying a new toilet, select a low-flush model that uses less than 1-1/2 gallons of water to flush, saving over 7,000 gallons per year per person.



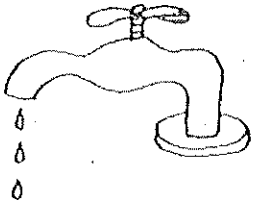
On Wash Day

- When purchasing a new washing machine, buy a water-saving model that can be adjusted to load-size and has a "suds-saving" option. New models use 40 percent less water than older models.
- For old and new machines, run full loads only.

Taking Water Conservation Outdoors

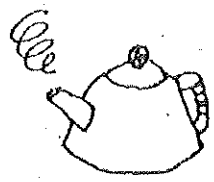
- Mow your lawn with water retention in mind. Set mower blades on a high setting (2- to 3-inch grass length as opposed to golf-course short) to provide natural ground shade and promote water retention by the soil.
- Water lawn and garden in the morning when evaporation is lowest.
- Water no more than 1 inch per week, applied slowly to prevent runoff. Place several empty cans around the yard when watering to determine how long it will take to water 1 inch.
- Collect rainwater for watering plants using a barrel covered with a screen.
- Plant indigenous species suited to your area and save as much as 54 percent of the water used to care for outdoor plants. Ask your local nursery for plant and grass species that require less water.
- When washing your car, turn off the hose between rinses to save up to 150 gallons per washing.
- Sweep down decks and driveways instead of hosing them down.

Give drinking water a hand.



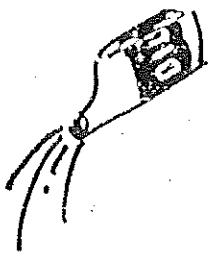
1. Waiting a week to fix a leak.

Assume little leaks only waste a little water? You can lose up to 200 gallons of water a day from a leaking toilet. And a faucet can drip 604,800 drops while you're waiting.



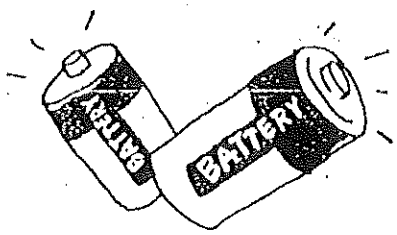
4. Taking a shortcut and using the hot water tap when cooking.

That's taboo, and it can shortcut your health. Lead can dissolve into hot water from lead pipes and solder. Cold water is better. Heat it on the stove when cooking or making baby formula.



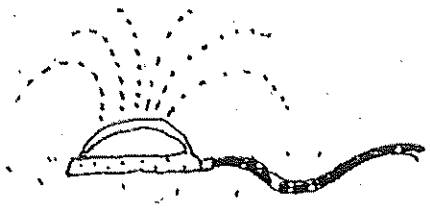
2. Slipping used motor oil into a storm sewer or burying it in the trash.

Hey slick, oil can leach into lakes, rivers, and wells. Just one pint can expand over an acre of water. Take your used oil to a recycling center.



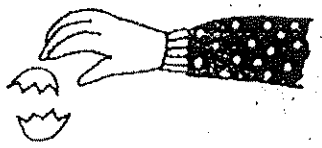
5. Tossing toxics in the trash.

How tacky! Consider batteries, a common throw-away. They contain lead and mercury. Some ordinary household cleaners have other poisons that contaminate water. Here's a tip, drop them off at a special collection site.



3. Watering your lawn at high noon.

Caught with your sprinkler on? The hot sun will evaporate the water your lawn needs. Better water early in the day.



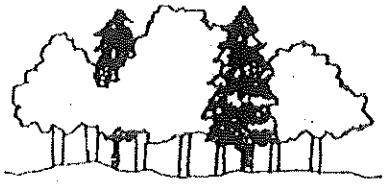
6. Using your garbage disposal all the time.

Want to show good taste after a meal? With your disposal using one gallon of water a minute, compost those food scraps. Another benefit, you'll be creating a great soil conditioner.

Blue Thumb Bloopers

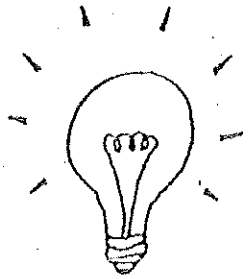
Embarrassing moments in the life of a water drinker

Give drinking water a hand.



7. Failing to check for the recycled mark on paper before buying it.

Still think recycled paper only helps trees? Recycled paper reduces water pollution from paper production by 35 percent. It saves water too — 7,000 gallons for every ton of paper.



8. Using electricity as if it didn't affect water.

It's time to shed some light on this. It takes more than 130 billion gallons of water a day to generate electricity in the U.S. Conserving energy is conserving water.

9. Thinking you can't make a difference.

It's never a blooper to take a stand for clean water, through your actions and through your words. So put your Blue Thumb knowledge to work and give drinking water a hand every day.

To find out more, order the "Blue Thumb Basics" brochure listing more than 50 additional ways to conserve and protect your drinking water. Send a self-addressed, stamped envelope to "Blue Thumb Basics," Public Information Department, American Water Works Association, 6666 W. Quincy Ave., Denver, CO 80235.

1. Know Your Drinking Water

Understand where your water supply comes from. Write your water supplier and request the list and schedule of water quality tests required by the Environmental Protection Agency. Study local well codes and ask your County Health Department for assistance before you drill a new well. Always hire a licensed driller for water well drilling and pump installation.

2. Test Your Well

There are more than 13 million wells supplying drinking water to people in the United States — most wells produce safe drinking water, but contamination can occur. If you have a well, have it regularly tested for contamination. The fact that a neighbor's well tests safe does not mean that your well is safe. Overloaded septic systems may be a source of well contamination. Ask your County Health Department for assistance.

3. Plug Abandoned Wells

Identify the abandoned water wells in your area or on your property and have them plugged by a licensed well driller. An open, abandoned well can draw contaminants directly from the surface into the aquifer below. In the past, some abandoned wells have been used for waste disposal.

4. Septic System Maintenance

If you have a septic system, pump it out every one to three years. Do not flush grease, caustics, and non-biodegradable materials into the system. Before installing a new septic system, read local code requirements. Have your system installed by a licensed individual. Do not use septic tank cleaners. They are not needed and can prove harmful.

5. Yank that Tank

Those old rusty underground storage tanks for oil and gasoline have become a menace. Federal law requires that abandoned underground storage tanks be removed from the ground and that leaking tanks must be replaced. If you have an underground tank on your property, have it checked for leaks.

6. Healthy Farming and Gardening

Pesticides and fertilizers leach down through the soil and into the groundwater below. If you farm or garden, practice the best livestock manure management practices available and test the soil to avoid over-application of fertilizers. Follow label recommendations for proper pesticide application. Do not apply chemicals if heavy rain is forecast. Learn about IPM (Integrated Pest Management). Contact your County Extension Office for further information.

7. Reduce, Reuse, Recycle

These are the three R's for those who are environmentally conscious. By molding our lifestyles after these three words, we can help prevent contamination of our groundwater resources. Remember, what goes into our garbage goes into our ground, and what goes into our ground goes into our groundwater.

8. Buy Recycled Products

Unless we demand recycled products there will not be a market for them. To strengthen the market, request recycled products at the local grocery store. Products made from recycled materials use only about half as much energy to produce. Paper made from recycled fibers reduces air pollution, saves trees, and creates five times as many jobs as paper made from virgin wood. Ask your local store to carry recycled products.

9. Become a Green Consumer

You can buy products which do not tax the environment or push toxins into your groundwater. A green product is one that has environmentally sound contents or is wrapped in environmentally sound packaging. Buy in bulk. Buy the economy size. Take your grocery bags back for a second trip. By becoming a green consumer you will save money by not purchasing packaging you will throw away as soon as you get home. SAY NO! to products that are over-packaged.

We all have it within our power to protect our drinking water.

Source: Michigan Tip of the Mit Watershed Council, adapted from the GEM Regional Groundwater Center "Ten Steps to Protect Your Drinking Water" poster.

PROTECT

WHAT YOU SHOULD KNOW ABOUT YOUR COMMUNITY DRINKING WATER...

Instructions:
(fill in answers, "white-out" directions, duplicate or print, and distribute)

Drinking Water Source(s):

Possible types of pollution:

Programs in place to protect the source:

Water provider:

Number of households receiving water:

Types of treatments used:

Number of tests done to test water quality:

Does the finished water meet or exceed USEPA standards?:

What are the key issues in terms of assuring the high quality of the community's water supply?:

How can the community join with the professionals to work on those issues?

Please contact the following organizations for more information.

EPA United States Environmental Protection Agency | Office of Water 4601 | EPA 810-F-95-001 April 1995

WATER TRIVIA FACTS

1. How much water does it take to process a quarter pound of hamburger?
   Approximately one gallon.

2. How much water does it take to make four new tires?
   2,072 gallons

3. What is the total amount of water used to manufacture a new car, including new tires?
   39,090 gallons per car

4. How many households use private wells for their water supply?
   17,000,000 households

5. Water is the only substance found on earth naturally in the three forms.
   True (solid, liquid, and gas)

6. Does water regulate the earth's temperature?
   Yes (it is a natural insulator)

7. How long can a person live without food?
   More than a month
   How long can a person live without water?
   Approximately one week, depending upon conditions.

8. How much water must a person consume per day to maintain health?
   2.5 quarts from all sources (*i.e.*, water, food)

9. How much water does a birch tree give off per day in evaporation?
   70 gallons

10. How much water does an acre of corn give off per day in evaporation?
    4,000 gallons

11. How many miles of pipeline and aqueducts are in the US and Canada?
    Approximately one million miles, or enough to circle the earth 40 times

12. What were the first water pipes made from in the US?
    Fire charred bored logs

13. How much water is used to flush a toilet?
    2-7 gallons

14. How much water is used in the average five-minute shower?
    25-50 gallons

15. How much water is used to brush your teeth?
    2 gallons

16. How much water is used on the average for an automatic dishwasher?
    9-12 gallons

17. On the average, how much water is used to hand wash dishes?
    20 gallons

18. How many community public water systems are there in the United States?
    56,000

19. How much water do these utilities process daily?
    34 billion gallons

20. Of the nation's community water supplies, how many are investor-owned?
    32,500

21. How much water does the average residence use during a year?
    107,000 gallons

22. How much water does an individual use daily?
    50 gallons

23. What does a person pay for water on a daily basis?
    National average is 25 cents

24. How much of the earth's surface is water?
    80%

25. Of all the earth's water, how much is ocean or seas?
    97%

26. How much of the world's water is frozen and therefore unusable?
    2%

27. How much of the earth's water is suitable for drinking water?
    1%

28. Is it possible for me to drink water that was part of the dinosaur era?
    Yes

29. If all community water systems had to be replaced, what would it cost?
    In excess of $175 billion

30. What does it cost to operate the water systems throughout the country annually?
    Over $3.5 billion

31. How much does one gallon of water weigh?
    8.34 pounds

32. How many gallons of water would it take to cover one square mile with one foot of water?
    219 million gallons

33. How much water is in one cubic foot?
    7.48 gallons

34. How many gallons of water do you get per acre, when it rains one inch?
    27,000 gallons per acre

35. At what temperature does water freeze?
    32 degrees F, 0 degrees C

36. At what temperature does water vaporize?
212 degree F, 100 degrees C

37. What is the most common substance found on earth?
Water

38. How much of the human body is water?
66%

39. How much of a chicken is water?
75%

40. How much of a pineapple is water?
80%

41. How much of a tomato is water?
95%

42. How much of an elephant is water?
70%

43. How much of an ear of corn is water?
80%

44. How much water does it take to process one chicken?
11.6 gallons

45. How much water does it take to process one can of fruit or vegetables?
9.3 gallons

46. How much water does it take to process one barrel of beer?
1,500 gallons

47. How much water does it take to make one board foot of lumber?
5.4 gallons

48. How much water does it take to make one pound of plastic ?
24 gallons

49. How much water does it take to make one pound of wool or cotton?
101 gallons

50. How much water does it take to refine one barrel of crude oil?
1,851 gallons

51. How much does it take to produce one ton of steel?
62,600 gallons

52. How much water does it take to process one ton of cane sugar to make processed sugar?
28,100 gallons

53. How much water does it take to process one ton of beet sugar to make processed sugar?
33,100 gallons

Water Myths & Realities

Myth: We have less water today than we did 100 years ago.
Reality: There is the same amount of water on Earth today as there was when the Earth was formed three billion years ago. The difference is that today many more demands are placed on water. Because our demands on water continue to grow but our supplies don't, everyone should lend a hand to conserve, protect, and get involved with decisions that affect our water resources.

Myth: We don't have to think about drinking water.
Reality: We can no longer take our drinking water for granted. Public participation is vital to protecting our water resources, building adequate treatment plants, improving water delivery, analyzing costs versus risks, and enacting appropriate legislation.

Myth: Once you use water, it's gone.
Reality: After water is used, it's recycled ... innumerable times. Some water is recycled for use within a week, other water may not be used again for years. Water is resilient and responds well to treatment. However, using water and abusing water by contaminating lakes, streams, and wells with toxic chemicals are two different things. To keep our drinking water safe, we need not only appropriate treatment, but also appropriate source protection.

Myth: If lead is in your water, it's the treatment plant's fault.
Reality: The most common source of lead in drinking water is plumbing in your home. Your plumbing may have lead pipes or lead solder in the connections. Lead is a contaminant that is particularly harmful to pregnant women and young children. If you are concerned about lead in your water, contact your local health authorities or water utility to find out how you can have your water tested by a certified laboratory. If tests reveal that the lead content of your water is above 15 parts per billion, you should reduce your exposure to it.
Hints: 1. Since warm water absorbs more lead than cold, always use cold water when you cook.
2. Because water standing in pipes tends to absorb lead, clear the pipes before drinking by letting your tap run until the water is cold.

Myth: There are more pollutants in drinking water today than there were 25 years ago.
Reality: Not necessarily. Twenty-five years ago, we did not have the technology to know what was in our drinking water. Today, we have sophisticated testing instruments that enable us to know more about our water than ever before. The drinking water community is continually improving treatment processes as it learns more each year.

Myth: Using a home water treatment device will make tap water safer or healthier to drink.
Reality: Some people use home water filters to improve the taste, smell, or appearance of their tap water, but it does not necessarily make the water safer or healthier to drink. Additionally, all home treatment devices require regular maintenance. If the maintenance is not performed properly, water quality problems may result.

Myth: Bottled water is safer than tap water.
Reality: Not necessarily. Unlike tap water, the quality of finished bottled water is not government-monitored. Studies have shown that microbes may grow in the bottles while on grocers' shelves. You don't need to buy bottled water for safety reasons if your tap water meets all federal, state, or provincial drinking water standards. If you want water with a different taste, you can buy bottled water, but it costs up to 1,000 times more than tap water. Of course, in emergencies, bottled water can be a vital source of drinking water for people without water.

Myth: "New" water is better than treated water.
Reality: There is very little water on Earth that is new. Most of our water has been touched by some type of human or animal activity. Even in remote wilderness areas, studies have found bacteria contaminating water. Therefore, it's always best to drink water that you know has been treated. Before drinking water from a stream, boil it for one minute at sea level or three minutes at higher elevations. This will completely kill all bacteria, viruses, and germs.

Water Q & A

Q. Can I tell if my drinking water is okay by just looking at it, tasting it, or smelling it?
A. No. None of the chemicals or microbes that could make you sick can be seen, tasted, or smelled.

Q. When I'm working in the yard, I'm tempted to take a drink from my garden hose. Is this safe?
A. No. The water is safe, but a standard vinyl garden hose has substances in it to keep it flexible. These chemicals, which may get into the water as it goes through the hose, are not good for you. In addition, the outside thread openings at the end could be covered with germs.

Q. If I travel overseas, in which countries is the water safe to drink?
A. Besides the United States and Canada, the water is generally safe to drink in western Europe, Australia, New Zealand, and Japan. In other countries, you should insist on carbonated bottled water for drinking and brushing your teeth.

Q. Is the fluoride and chlorine in my drinking water safe?
A. Yes. When added or naturally present in the correct amounts, fluoride in drinking water has greatly improved the dental health of American and Canadian consumers. Many tests have shown that the amount of chlorine found in treated water is safe to drink, although some people object to the taste. NOTE: even in the correct amounts, fluoride or the disinfectant chloramine in drinking water makes the water unsuitable for use in kidney dialysis machines or aquariums.

Q. Water often looks cloudy when first taken from a faucet and then it clears up. Why is that?
A. The cloudy water is caused by tiny air bubbles in the water similar to the gas bubbles in beer and carbonated soft drinks. After a while, the bubbles rise to the top and are gone.

Q. What is "hard" water?
A. The answer may surprise you. Hardness in drinking water is caused by two nontoxic chemicals-usually called minerals — calcium and magnesium. If either of these minerals is present in your water in substantial amounts, the water is said to be "hard," because making a lather or suds for washing is "hard" (difficult) to do. Thus cleaning with hard water is difficult. Water containing little calcium or magnesium is called "soft" water. (Maybe it should be called easy, the opposite of difficult.) Water that does not contain enough calcium or magnesium may be "too soft."

Q. What is the cost of the water I use in my home?
A. Prices vary greatly around the United States and Canada, but the typical cost is about $2 for 1,000 gallons/3785 litres. At that price you get approximately 5 gallons/20 litres of tap water for a penny.

Q. Many areas near the ocean do not have large supplies of fresh water. Why can't ocean water be treated to make drinking water
A. Ocean water can be treated, but the process is expensive. The cost of converting salt water to drinking water has been estimated at $5 to $7 for each 1,000 gallons/3785 litres instead of the $.30 to $.50 for treating 1,000 gallons/3785 litres of fresh water.

Q. Why is ocean water salty?
A. Rainwater doesn't contain any salt, but when it falls on the ground, salt from the soil dissolves in the water as it flows back down to the ocean. When this water evaporates from the ocean, the salt stays behind. This has been going on for more than a billion years. That is why the ocean is now very salty.

From Plain Talk About Drinking Water: Questions and Answers About the Water You Drink by Dr. James M. Symons, published by American Water Works Association.

Water Facts of Life

"Ride the Water Cycle" with these fun facts.

- There is the same amount of water on Earth as there was when the Earth was formed. The water from your faucet could contain molecules that dinosaurs drank.
- Water is composed of two elements, Hydrogen and Oxygen. 2 Hydrogen + 1 Oxygen = H_2O.
- Nearly 97% of the world's water is salty or otherwise undrinkable. Another 2% is locked in ice caps and glaciers. That leaves just 1% for all of humanity's needs — all its agricultural, residential, manufacturing, community, and personal needs.
- Water regulates the Earth's temperature. It also regulates the temperature of the human body, carries nutrients and oxygen to cells, cushions joints, protects organs and tissues, and removes wastes.
- 75% of the human brain is water and 75% of a living tree is water.
- A person can live about a month without food, but only about a week without water.
- Water is part of a deeply interconnected system. What we pour on the ground ends up in our water, and what we spew into the sky ends up in our water.
- The average total home water use for each person in the U.S. is about 50 gallons a day.
- The average cost for water supplied to a home in the U.S. is about $2.00 for 1,000 gallons, which equals about 5 gallons for a penny.
- Water expands by 9% when it freezes. Frozen water (ice) is lighter than water, which is why ice floats in water.

Be Hydro-Logical

FACT: More water is used in the bathroom than any other place in the home.
ACTION: Turn off the water when you brush your teeth and shave. Install low-flow toilets, shower heads and faucet aerators and you'll save thousands of gallons/liters of water a year. It's a savings that should reduce your water bill.

FACT: Today there are many more people using the same amount of water we had 100 years ago.
ACTION: Don't waste water. Use it wisely and cut back wherever you can.

FACT: A dripping faucet can waste up to 2,000 gallons/7,600 liters of water a year. A leaky toilet can waste as much as 200 gallons/260 liters of water a day.
ACTION: Check your plumbing and repair any leaks as soon as possible.

FACT: Lead in household plumbing can get into your water.
ACTION: Find out if your pipes are lead or if lead solder was used to connect the pipes. If you have lead in your plumbing system, when you turn on the tap for drinking or cooking, let the water run until it's cold. Never use water from the hot tap for cooking or drinking.

FACT: What's dumped on the ground, poured down the drain, or tossed in the trash can pollute the sources of our drinking water.
ACTION: Take used motor oil and other automotive fluids to an automotive service center that recycles them. Patronize automotive centers and stores that accept batteries for recycling. Take leftover paint, solvents, and toxic household products to special collection centers.

FACT: On average, 50% - 70% of household water is used outdoors for watering lawns and gardens.
ACTION: Make the most of the water you use outdoors by never watering at the hottest times of the day or when it's windy. Turn off your sprinklers when it's raining. Plant low-water use grasses and shrubs to reduce your lawn watering by 20% - 50%.

FACT: Lawn and garden pesticides and fertilizers can pollute the water.
ACTION: Reduce your use of pesticides and fertilizers and look for safer alternatives to control weeds and bugs. For example, geraniums repel Japanese beetles; garlic and mint repel aphids; and marigolds repel white flies.

FACT: Although most people get their water from regulated community water supplies, others rely on their own private wells and are responsible for their own water quality.
ACTION: If you own a well, contact your local health department or Cooperative Extension Service representative to find out how to test the quality of your well water.

FACT: Your city government and state officials regularly make decisions that affect the quality of your drinking water resources.
ACTION: As the population grows and housing and industrial interest expand, attend local planning and zoning meetings and ask what's being done to protect water resources from contamination. Let elected officials know that you expect them to use their hydro-logic to protect the water.

FACT: Public water utilities regularly test the quality of the drinking water they provide to customers.
ACTION: Call your water utility and ask for a copy of their latest water quality report.

WATER WISE
DO NOT
WASTE IT

How much water does your family use?
Multiply the amount of water you use for each activity below by the number of times each day you do it. Then multiply that figure by the number of people in your household.

		Times/day	#in family	
Toilet Flushing	5gal.	x____	x____	=____
A short shower	25gal.	x____	x____	=____
Tub bath	35gal.	x____	x____	=____
Teeth brushing	2gal.	x____	x____	=____
Washing dishes with water running	30gal.	x____	x____	=____
Washing dishes with a basin	20gal.	x____	x____	=____

Total for family_____

How much water did you use today?
This shows your every day use of water not including the laundry, lawn, garden, and car washing.

Water wise

PERSONAL WATER METER
GALLONS USED PER DAY

170	
165	
160	
155	
150	
145	
140	
135	
130	
125	
120	
115	
110	
95	
90	
85	
80	
75	
70	
65	
60	
55	
50	
45	
40	
35	
30	
25	
20	
15	
10	
5	

Toilet

3.5 gals/flush x _____ flushes per day = _____ gallons
(for low-flow toilet use:)

1.6 gals/flush x _____ flushes per day = _____ gallons

Shower

4 gals/min x _____ minutes to shower = _____ gallons
(for low-flow showerhead use:)

2.5 gals/min x _____ minutes to shower = _____ gallons

Brushing Teeth

2 gals/min x _____ minutes water is running = _____ gallons

Food & Drink

2gals/min x _____ minutes water is running = _____ gallons

Washing Dishes

2gals/min x _____ minutes water is running = _____ gallons

15 gallons per load in dishwasher x _____ number of loads = _____ gallons

Washing Machine

55 gallons per load in machine x _____ number of loads = _____ gallons

Other

THE BLUE THUMB QUIZ

Here are 20 quick questions to find out if you know how to give drinking water a hand.

Mark the following true or false and compare your answers with those on the back of this sheet.

TRUE FALSE

☐ ☐ 1. Installing a low-flow toilet can save a family of four more than 45 gallons of water a day.

☐ ☐ 2. More than 75 percent of the water in the United States is located underground.

☐ ☐ 3. Reading the labels on common household products won't tell you what products are harmful to water.

☐ ☐ 4. Americans improperly dispose of more oil in a year than the Exxon Valdez spilled.

☐ ☐ 5. Even when a recipe calls for using warm or hot water, you should draw cold water from the tap and heat it on the stove or in the microwave.

☐ ☐ 6. It's safe to drink water directly from remote streams.

☐ ☐ 7. There are ways to landscape that use between 30 - 80 percent less water than traditional landscaping.

☐ ☐ 8. If you have your own well, you can be sure your water is safe.

☐ ☐ 9. You can drink more than 4,000 eight-ounce glasses of tap water for the same cost as a six-pack of soda pop.

☐ ☐ 10. Common outdoor bug and weed killers can contaminate underground water or end up in your local river or lake.

☐ ☐ 11. The quality of U.S. drinking water is not regulated by the federal government for safety.

☐ ☐ 12. Two-thirds of the water you use at home you use in the bathroom.

☐ ☐ 13. Trash and debris around a lake won't affect water quality.

☐ ☐ 14. It's better for water if you dry out leftover household products such as furniture polish, car wax, or latex paint, before disposing of them.

☐ ☐ 15. More than 800,000 new water wells are drilled each year for domestic, commercial, and industrial use.

☐ ☐ 16. Letting the water run while you brush your teeth or shave is water wise.

☐ ☐ 17. New water sources are being discovered every day.

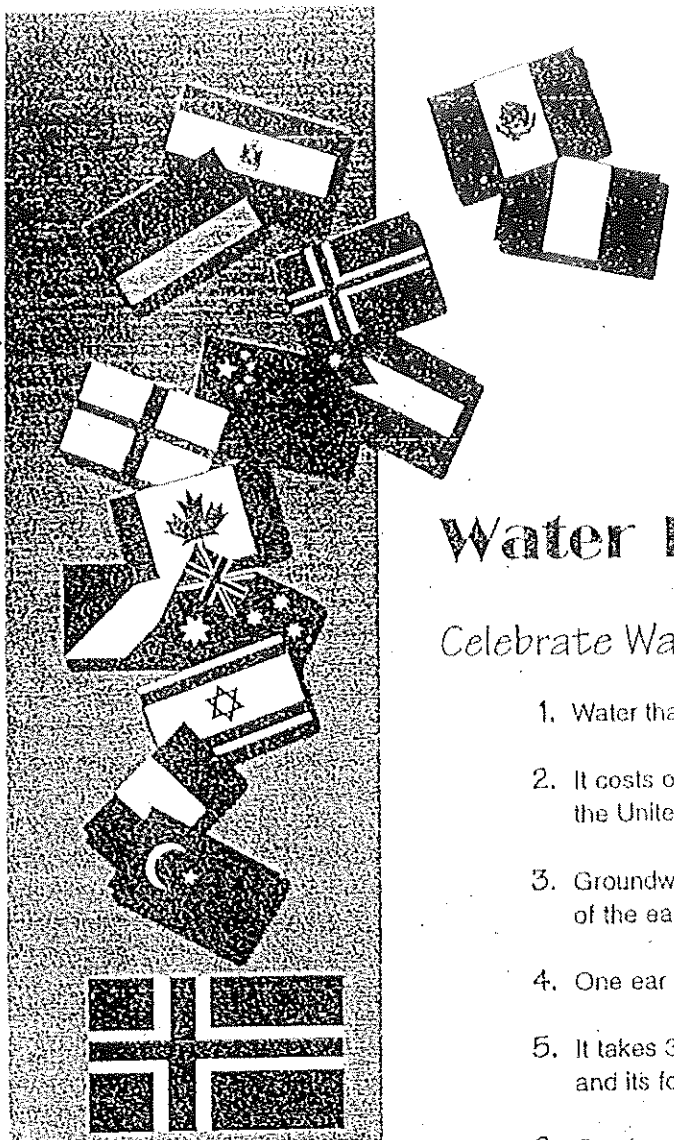
☐ ☐ 18. An abandoned well can be left unsealed without jeopardizing the ground-water source.

☐ ☐ 19. You can ignore a leaky faucet at work or at school... it's only worth saving water at home.

☐ ☐ 20. You can influence decisions your community makes on drinking water.

BLUE THUMB QUIZ ANSWERS

1. True. That's 1,350 gallons a month!
2. True. However, 50 percent of U.S. drinking water is from surface sources.
3. False. Don't buy products that say "poisonous, toxic, corrosive," etc.
4. True.
5. True. Heat can dissolve lead from pipes and solder into your water. New houses with lead-free solder are not as likely to have lead problems.
6. False. Giardiasis can be caused by animal wastes in remote untreated streams.
7. True. It's called Xeriscape™.
8. False. Contaminants can seep through the ground — have your well tested for contaminants by your local Health Department.
9. True. In some cities, the number of glasses can go as high as 15,000.
10. True. They can seep into the water under ground or rain can wash them into surface water.
11. False. The U.S. government regulates quality and currently has standards for more than 80 contaminants.
12. True. Showers and toilets are the major users.
13. False.
14. True. Even though some landfills have a protective lining, leakage can occur and contaminate groundwater.
15. True. Many are drilled to monitor water quality in aquifers and in areas around dump sites.
16. False. It wastes water.
17. False. We have identified or are using most water sources in the U.S.
18. False. All unused wells should be capped. Open wells can provide a route for contaminants to reach aquifers.
19. False. It's smart to save water no matter where you are.
20. True. Call your water utility company, speak up at public meetings, write a letter to your City Council — you can affect decisions!

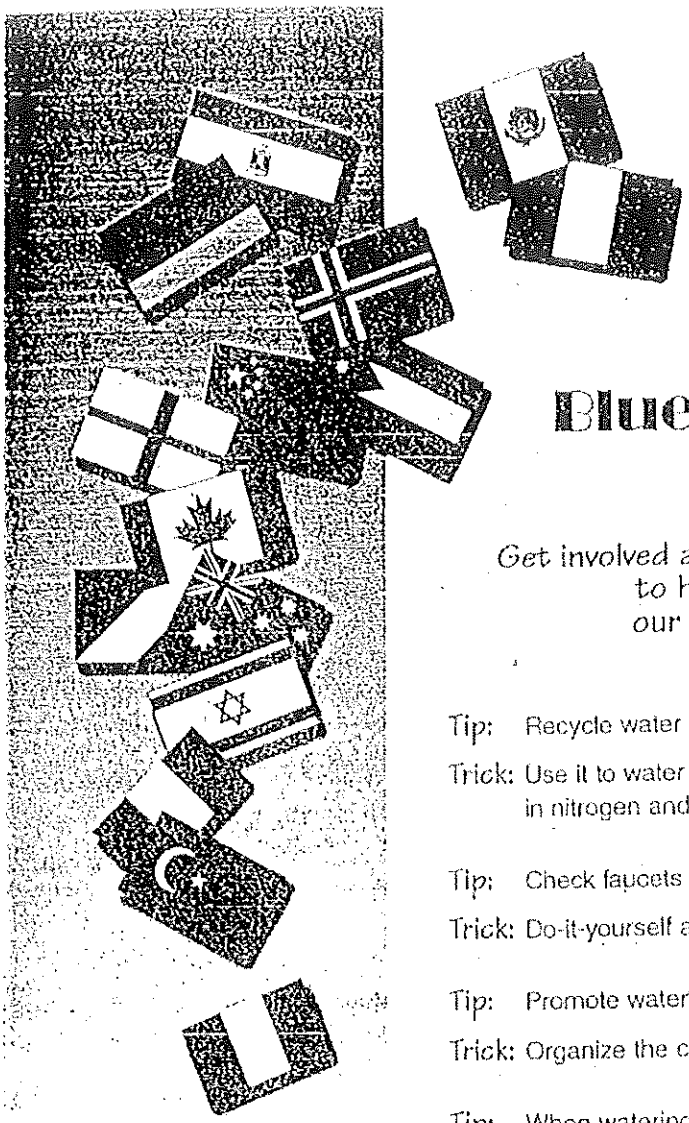


The word walrus comes from Iceland by way of Scandinavia. In Icelandic, this animal is called a hross-hwair, meaning a "horse whale" because of its horselike neighing. In Scandinavia, the name became "whale horse" or "walrus" in English.

Water Facts of Life

Celebrate Water with these fun facts.

1. Water that is safe to drink is called potable (pronounced pó'ta-bal).
2. It costs over $3.5 billion to operate water systems throughout the United States each year.
3. Groundwater is water that sinks into the upper portion of the earth's surface.
4. One ear of corn is 80% water.
5. It takes 39,090 gallons of water to manufacture a new car and its four tires.
6. For the price of a single can of soda—an average 50 cents—many communities deliver up to 1,000 gallons of fresh, clean drinking water to homes.
7. Each year, nearly 10,000 cubic miles of water flows along the world's rivers to the oceans.
8. Public water suppliers in the US process nearly 34 billion gallons of water per day for domestic and public use.
9. On average, 50%–70% of household water is used outdoors for watering lawns and gardens.
10. Americans drink more than 1 billion glasses of tap water per day.



Blue Thumb Tips and Tricks

Get involved and use these Blue Thumb Tips and Tricks to help conserve and protect water, our most precious natural resource.

Tip: Recycle water from fish tanks.

Trick: Use it to water plants. Fish emulsion is a good, inexpensive fertilizer high in nitrogen and phosphorous.

Tip: Check faucets for leaks.

Trick: Do-it-yourself and replace worn washers periodically.

Tip: Promote water pollution prevention in your neighborhood.

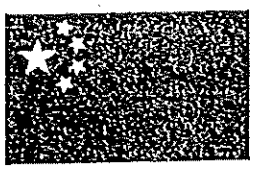
Trick: Organize the cleanup of a river, lake, stream, or canal in your community.

Tip: When watering the lawn, avoid watering the house, sidewalk, or street.

Trick: Adjust sprinklers so only the lawn is watered.

Tip: Don't let the tap run every time you want a drink.

Trick: Fill a pitcher with tap water and put it in the fridge.



The Chinese discovered the purifying effects of boiling water.

Tip: Never pour toxic chemicals down the drain, on the ground, or in the trash.

Trick: Choose natural household cleaners like borax, ammonia, vinegar, and baking soda and recycle hazardous household waste at waste collection centers.

Tip: Promote water conservation by watering trees and plants only once a week.

Trick: Place a layer of mulch around trees and plants to retain water.

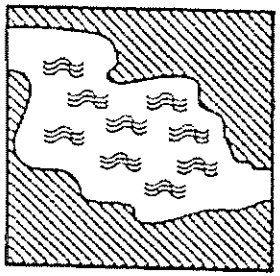
Tip: Know how often your lawn needs watering.

Trick: Use a moisture indicator to tell when your lawn needs watering and when it doesn't.

Tip: Get involved and voice your opinion about water issues in your community.

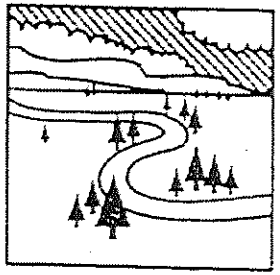
Trick: Attend a water board or planning commission meeting.

The Decision Process for Drinking Water.



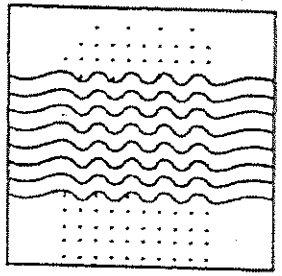
Source

- Does the drinking water come from lakes, rivers, or wells?
- How clean is the source?
- How much is there?
- How do we finance it?
- How do we protect it?
- What type of recreational uses are appropriate?



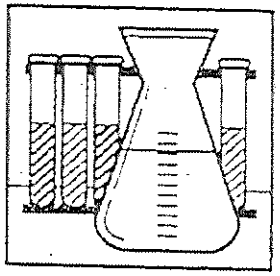
Transport

- How far must the water travel?
- Over what type of land?
- What is the cost to move it?



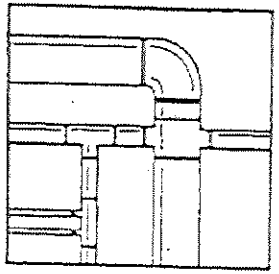
Treatment

- What type of treatment does the water need?
- Are the facilities adequate?
- How do we finance treatment?
- Is more research needed?



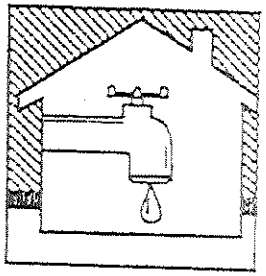
Testing

- What federal and state tests are required?
- How safe is the water?
- What must the public be told?



Delivery

- Where must the water go?
- Is the delivery system adequate?
- Does the system allow the community to grow?
- How is the system financed?



Home

- Do you ever run out of water?
- Do you have lead pipes or solder?
- Do you know how to reduce lead in your water?
- Do you waste water?
- How much do you value your water?

http://www.epa.gov/safewater/kids/wsb/index.html

The Water Sourcebook Series

The Water Sourcebook Series (K - 12) is now available on CD ROM.

The Water Sourcebook Series was developed in partnership with EPA, Region 4, the Alabama Department of Environmental Regulation, and LEGACY - Partners in Environmental Education over a 6-year period. The hard copy Water Sourcebook Series consists of a set of 4 volumes appropriate for Grades K - 2, Grades 3 - 5, Grades 6 - 8, & Grades 9 - 12. Each volume is a flexible comprehensive environmental education program on water issues. The Water Sourcebook Series explains the water management cycle using a balanced approach and how it affects every aspect of the environment. The curriculum provides strong science and math content, but also links these subject areas to social studies and language arts. Each Water Sourcebook contains hands-on activities and investigations, fact sheets, reference materials, and a glossary of terms. There are 5 chapters contained in each book, Introduction to Water, Drinking Water and Wastewater Treatment, Surface Water Resources, Ground Water Resources, and Wetland and Coastal Waters. The Water Sourcebook helps kids learn about water, "use what you need and don't pollute" is the message sent to children through the Water Sourcebook Series.

Over 58,000 copies of the hard copy Water Sourcebook Series (Grades K - 2, Grades 3 - 5, Grades 6-8 & Grades 9 -12) have been printed and over 10,000 CD ROM have been produced. A hard copy Spanish version is available for the Grades 3 - 5. The majority of the teacher training and distribution of the books are being done in Alabama by LEGACY - Partners in Environmental Education, in Georgia by the Georgia Water Wise Council, and throughout the remaining United States and in foreign countries by the Water Environment Federation. Over 20 Countries throughout the world have used the Water Sourcebook Series to educate their children.

For Further Water Sourcebook Series Information Contact:

EPA, R4 - (404) 562 - 9345
www.epa.gov

LEGACY, Inc. in Alabama - (334) 270 - 5921
www.legacyenved.com

Georgia Water Wise Council - (770) 483 - 9474
www.griffin.peachnet.edu/waterwise/wwc.htm

Water Environment Federation - (800) 666 - 0206
www.wef.org

included at the end of the guide to help equip teachers to deal with concepts and words used in the text which may be unfamiliar.

ORGANIZATION OF INDIVIDUAL ACTIVITIES

Each activity is organized in the same way, detailing objectives, materials needed, background information, and procedures. Following is a brief summary of what you should expect to find in each activity.

OBJECTIVES:	Describes what the student should be able to do when the activity is completed.
SUBJECT:	The general subject(s) to which the activity applies: Sciences, Mathematics, Social Studies, Language Arts, and so on.
TIME:	The approximate number of minutes needed to complete the main exercise(s). More time may be needed for the follow-up and extension exercises. Some activities or follow-ups may require collecting data over several days/weeks, but will only need major time blocks at the beginning and end of the activity to explain, present information, and reach conclusions.
MATERIALS:	List of materials needed to complete activity. Alternatives and optional materials are listed where appropriate. If the basic materials are not immediately available in your classroom, they can often be borrowed from other classes in the school, or local college or university science departments, local government agencies, or area businesses.
BACKGROUND INFORMATION:	Background information specific to the activity. This material is suggested as a basis for teacher lecture and/or student discussion when the found in the Fact sheets located in the back of the guide.)
ADVANCE PREPARATION:	Directions for the teacher/student to prepare materials in advance.
PROCEDURE:	Complete directions to conduct the entire activity, including follow-up and extension ideas. Includes teacher sheets, student sheets, and teacher keys.
Setting the Stage	Introduction of the main ideas of the activity to the students. This section may use student discussion questions/topics, sharing the pertinent background information, a demonstration or activity, or a combination of these.

Activity	Step-by-step instructions on how to do the activity. This sometimes ends with questions to demonstrate that students understand what they have done.
Extension	Suggestions for extending the activity into other subject areas and/or suggestions for other related activities. This part of the activity is optional. Some may be used as ongoing projects, while others may be used as additional classroom work for advanced students or for extra credit.
RESOURCES:	Reference materials used either in developing the activity or to provide additional information and addresses for ordering materials used in the activity.

ACTIVITY PREPARATION

Once you have decided on the activity(ies) you will be doing, check the materials list. You will need to take into account the number of students or student teams in your class(es). Many materials are readily available, but some may need to be borrowed or purchased ahead of time.

Prepare copies of all the needed student handouts and/or transparencies or other materials for your use. Most activities contain ready-made masters for these. Teacher and student sheets can be easily removed from the binder and replaced after photocopying or producing a thermofax master for print duplication. Some activities also contain suggestions to make a transparency for use with an overhead projector. Transparencies may be made by a thermofax, a photocopier, or by tracing.

If you plan to have the students do part or all of the extension suggestions, you will want to add additional materials to your list. You may also need to locate other sources of information or telephone numbers to complete the extension. Many resource names and numbers can be found in the back of this book. Some extensions can be started simultaneously with the regular activity.

As you read through the activity, decide whether you will do optional suggestions. Check the suggested time for completion of the activity and add time needed to do any extension activities. The time needed may vary from class to class. These activities have all been field tested in secondary school classrooms. However, you might want to do a trial run of the activity yourself to evaluate the time needed and areas where minor problems might occur. It is also a good idea to mark points in the text where natural breaks can be taken to divide the activity into class periods.

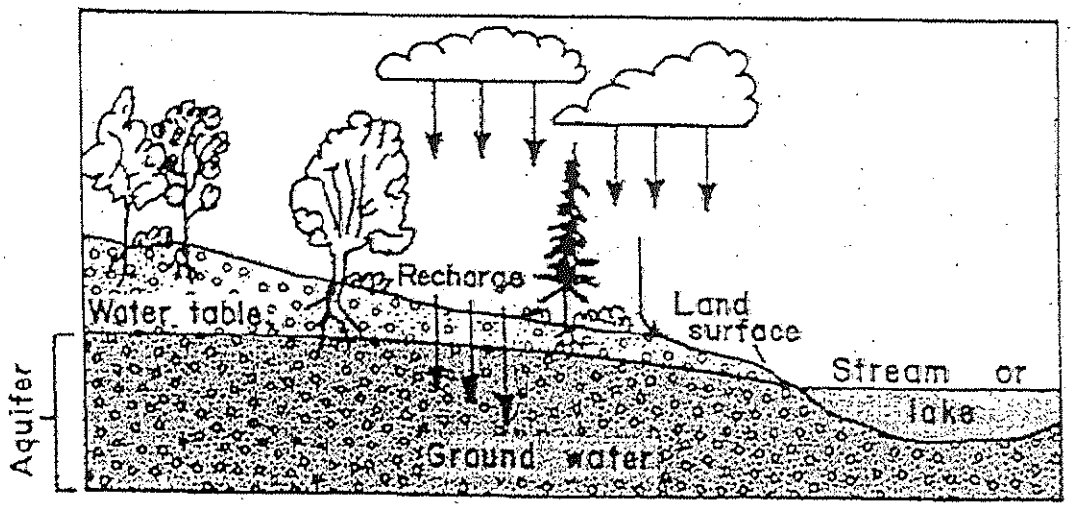
The fact sheets included in the back of the guide and the background material included in each activity should provide the information necessary for your preparation. Further reading may be found in the list of resources at the conclusion of each activity. If these resources are not readily available, lists of additional resources are provided at the back of this Sourcebook.

PAGINATION

Each chapter is page-numbered separately and is designated with an appropriate chapter number. For example, the "Introduction" chapter begins with page 1-1, the "Drinking Water and Wastewater Treatment" chapter begins with 2-1, and so on.

How does water get into the ground?

When rain falls to the ground, the water does not stop moving. Some of it flows along the land surface to streams or lakes, some is used by plants, some evaporates and returns to the atmosphere, and some seeps into the ground. Water seeps into the ground much like a glass of water poured onto a pile of sand.



As water seeps into the ground, some of it clings to particles of soil or to roots of plants just below the land surface. This moisture provides plants with the water they need to grow. Water not used by plants moves deeper into the ground. The water moves downward through empty spaces or cracks in the soil, sand, or rocks until it reaches a layer of rock through which water cannot easily move. The water then fills the empty spaces and cracks above that layer. The top of the water in the soil, sand, or rocks is called the **water table** and the water that fills the empty spaces and cracks is called **ground water.**

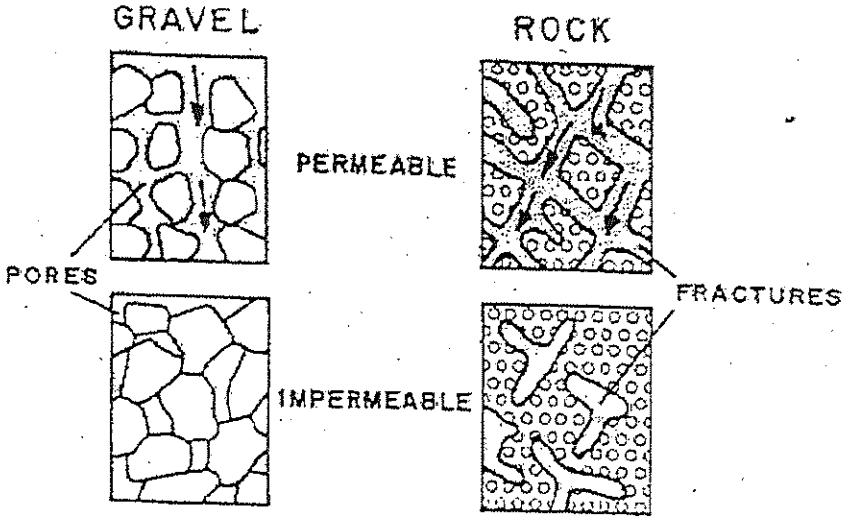
Water seeping down from the land surface adds to the ground water and is called **recharge** water. Ground water is recharged from rain water and snowmelt or from water that leaks through the bottom of some lakes and rivers. Ground water also can be recharged when watersupply systems (pipelines and canals) leak and when crops are irrigated with more water than the plants can use.

At least some ground water can be found almost everywhere. The water table may be deep, such as under a hillside, or shallow such as under a valley. The water table may rise or fall depending on several factors. Heavy rains or melting snow may increase recharge and cause the water table to rise. An extended period of dry weather may decrease recharge and cause the water table to fall.

What is an aquifer?

Aquifer is the name given to underground soil or rock through which ground water can easily move. The amount of ground water that can flow through soil or rock depends on the size of the spaces in the soil or rock and how well the spaces are connected. The amount of spaces is the **porosity**. **Permeability** is a measure of how well the spaces are connected.

Aquifers typically consist of gravel, sand, sandstone, or fractured rock such as limestone. These types of materials are **permeable** because they have large connected spaces that allow water to flow through. The spaces in a gravel aquifer are called **pores**. The spaces in a fractured rock aquifer are called **fractures**. If a material contains pores that are not connected, ground water cannot move from one space to another. These materials are said to be **impermeable**. Materials such as clay or shale have many small pores, but the pores are not well connected. Therefore, clay or shale usually restrict the flow of ground water. The next illustration shows how the connections between the pores or fractures control how water moves through an aquifer.



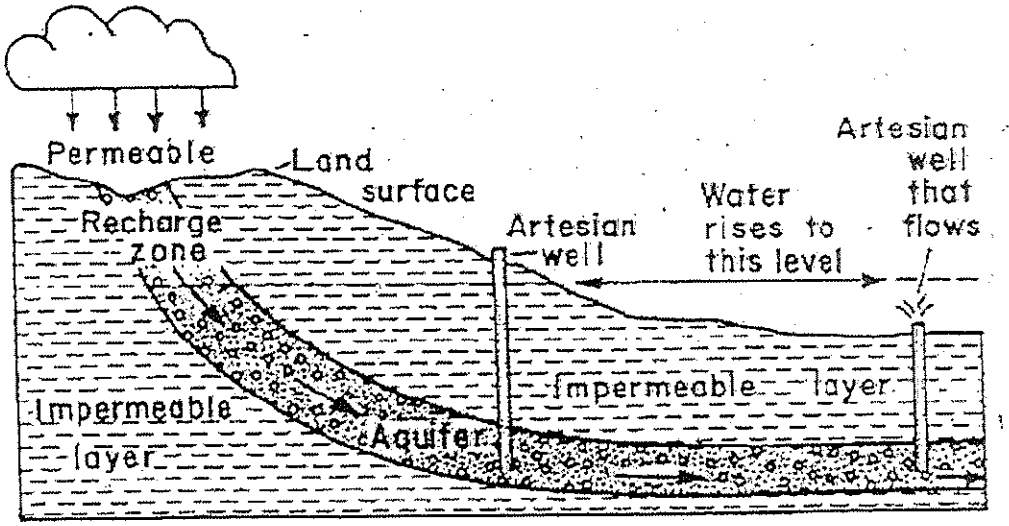
Who uses ground water?

More than 50 percent of the people in the United States, including almost everyone who lives in rural areas, use ground water for drinking and other

household uses. Ground water is also used in some way by about 75 percent of cities and by many factories. The largest use of ground water is to irrigate crops.

How do you get water out of the ground?

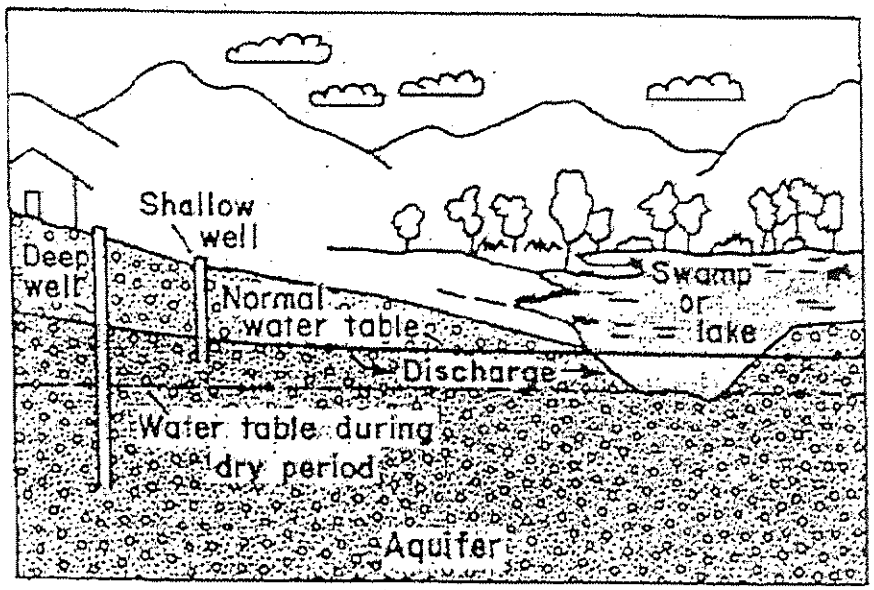
Ground water can be obtained by drilling or digging wells. A well is usually a pipe in the ground that fills with ground water. This water can then be brought to the land surface by a pump. Shallow wells may go dry if the water table falls below the bottom of the well, as illustrated below.



Water leaving an aquifer is called **discharge** water. Water that is pumped from a well is discharge water. Ground water might also discharge naturally as springs or into swamps, lakes, or rivers.

Some wells, called **artesian wells**, do not need a pump. These wells are drilled into an **artesian aquifer** which is sandwiched between two impermeable layers. Water enters an artesian aquifer in a permeable recharge zone which can be miles away from the well.

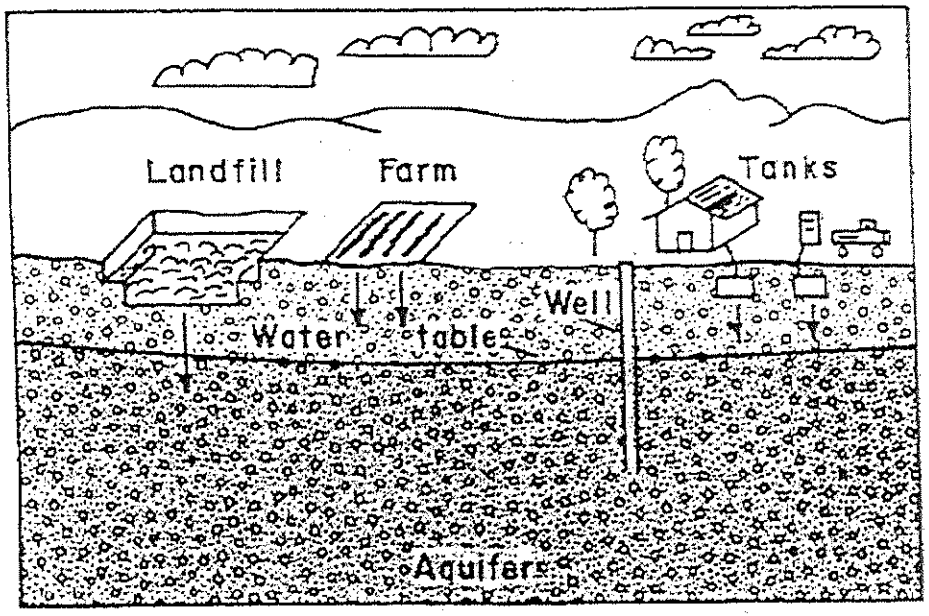
When a well is drilled into an artesian aquifer, pressure pushes water in the well above the top of the aquifer. If the pressure is high enough, water can flow from an artesian well.



Can we run out of ground water?

We can run out of ground water if more water is discharged than recharged. For example, during periods of dry weather, recharge to the aquifers decreases. If too much ground water is pumped during these times the water table can fall and wells may go dry.

Ground water can become unusable if it becomes polluted and is no longer safe to drink. In areas where the material above the aquifer is permeable, pollutants can seep into ground water. Ground water can be polluted by seepage through landfills, from septic tanks, from leaky underground fuel tanks, and sometimes from fertilizers or pesticides used on farms as shown below.



However, with careful use and by reducing sources of pollution, ground water can continue to be an important natural resource in the future.

For additional information:
1-888-ASK-USGS

D.W. Clark D.W. Briar 1993

USGS Ground Water Information Pages

Fact Sheet Home Page | Environment | Hazards | Information Management | Resources | State

U.S. Department of the Interior, U.S. Geological Survey
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URL: http://pubs.water.usgs.gov/OFR93-643

Massachusetts Department of ENVIRONMENTAL PROTECTION

fact sheet

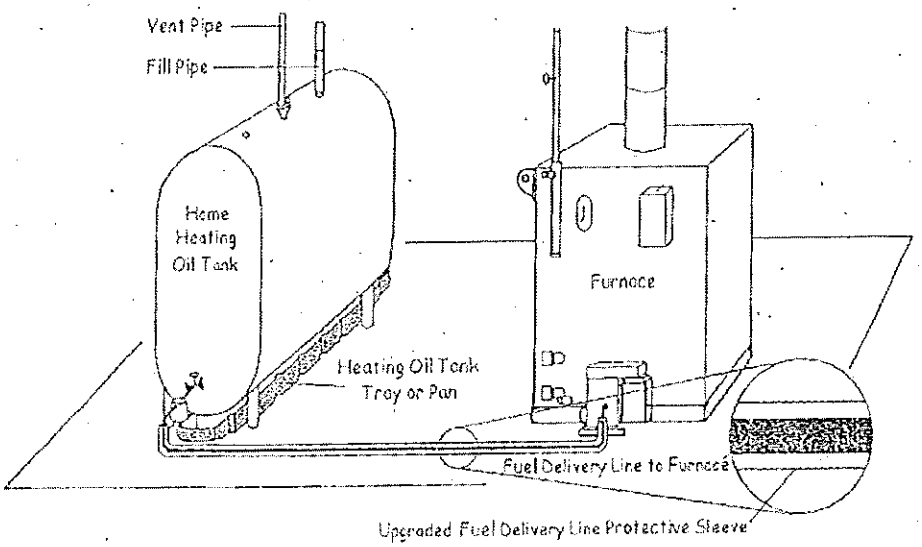
Tips For Maintaining Your Home Heating System: Prevent Heating Oil Leaks and Spills

Cleaning up oil leaks from home heating systems can be very expensive. The average cost can range between $20,000 and $50,000, with some cleanups costing significantly more. Here are some ways to save money, help prevent leaks and spills, and protect the environment.

For all heating oil systems:

- Annually:
  - Inspect for leaks. Look at the tank, fuel delivery line, valves, piping, and fittings.
  - Have your oil company:
    - ✓ Clean the furnace and repair or replace damaged parts. A well-maintained furnace means lower fuel bills and cleaner emissions.
    - ✓ Install an oil safety valve or replace the fuel delivery line with one encased in a protective sleeve. These are inexpensive upgrades. Contact the fire department to determine if a permit is required for this work.
  - Each fall, inspect the vent pipe to ensure that it is free of obstructions and that an audible signal (whistle) is on the vent. Oil company personnel listen for the whistle to help avoid overfills, a common source of spills.
- At least every 10 years, have the oil tank cleaned out. Over time, water (from condensation) and sludge can cause corrosion resulting in leaks.
- When appropriate:
  - Remove abandoned fill and vent pipes immediately.
  - Clearly mark the location of the tank's fill pipe.
  - Consider upgrading to a modern, fuel-efficient furnace.

Typical Above-Ground Home Heating Oil System



For underground tanks:

- Determine if the underground storage tank is made of steel (common) or fiberglass (rare). Most steel underground storage tanks will last approximately 10 to 20 years. If the tank is older than that or the age is unknown, replace it with an above-ground storage tank. Locate your new tank under a shelter, or inside a basement or garage, to prevent rust, corrosion, or damage.

For outdoor above-ground tanks:

- Ask your oil company to inspect the stability of the above-ground tank. A full 275-gallon tank weighs more than 2,000 pounds! They have metal legs and should sit on a concrete pad. If the legs become loose or the pad cracks, the tank can fall over and rupture.
- Replace an outdoor above-ground storage tank that has been uncovered for 10 years or longer. These tanks rust from the inside out, so cleaning or painting the outside does not usually prolong their life.
- Protect the tank from the weather, such as falling snow and ice, and prevent ruptures by tree limbs.

For indoor above-ground tanks:

- Inspect indoor above-ground storage tanks for signs of pitting and corrosion, particularly at the bottom of the tank. Tanks primarily rust from the inside out, so if signs of aging are present, replace the tank. Indoor tanks do not last more than about 30 years, and often their lifespan is much shorter.
- Consider placing a plastic heating oil tray or pan under the tank. This makes it easier to keep the tank area clean and help identify and contain small leaks.

If your oil company offers to perform a "tightness test," ask if this could cause a problem. Generally, these tests should NOT be performed on older residential heating oil systems. Because of the pressure used during a tightness test, older equipment can fail, causing a leak or spill. If you have a tank, fuel delivery line, valves, piping, and fittings on which it is inadvisable to perform a tightness test because of age or condition, then it is probably better to replace the equipment that is causing the concern.

Visit our Web site or call for more information. Access DEP's Web site at http://www.mass.gov/dep/bwsc/facts.htm to review related documents, including "Heating Oil Delivery Lines" (http://www.mass.gov/dep/bwsc/files/deline.htm), or call the DEP Helpline (617-338-2255 or 800-462-0444) and select option 2.

If you suspect an oil leak or spill, immediately contact your oil company and fire department for assistance. Leaks or spills of 10 gallons or more must be reported to DEP within 2 hours. To report a leak or spill, call DEP (within 2 hours) and the fire department.

DEP's 24-hour statewide emergency response number is 888-304-1133.

Massachusetts Department of
Environmental Protection
One Winter Street
Boston, MA 02108-4746

Commonwealth of
Massachusetts
Jane Swift, Governor

Executive Office of
Environmental Affairs
Bob Durand, Secretary

Department of
Environmental Protection
Lauren A. Liss, Commissioner

Produced by the
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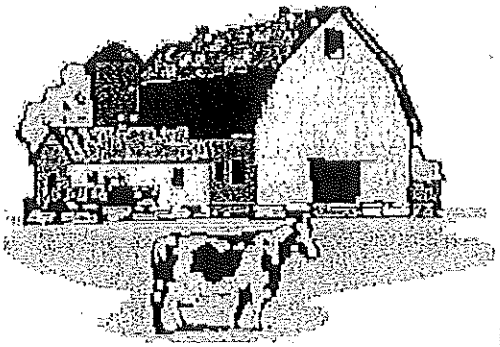
Printed on recycled paper.

This information is available in
alternate format by calling our
ADA Coordinator at
(617) 574-6872.

Manure Management: Protecting Water Resources from Nutrient Pollution

Animal waste from barnyards, manure pits and field application can pollute ground and surface water when not contained or applied properly. By making Best Management Practices (BMPs) part of a conservation plan, a farmer can greatly reduce the chances of contamination. A manure system should prevent contamination of water in lakes, streams, springs and wells.



BMPs are managerial, such as manure management, rotational grazing, and conservation tillage, or structural, such as manure pits or lagoons, terraces and fencing.

You can prevent contamination of groundwater by observing the following practices:

MANAGERIAL

Apply manure appropriately - Determine the rate of application that will fulfill the crop's nutrient needs without causing environmental problems. This includes:

- **Timing** - Spread manure only when conditions are favorable. Avoid spreading manure in the winter or early spring, because manure applied to frozen ground can pollute surface waters during spring thaw run-off. If winter application is required, only spread manure on sod-covered fields where manure won't runoff as easily. *Do not spread manure in early spring, because the soil is often saturated.*
- **Location** - Avoid spreading manure on sloped lands or areas where manure could seep into water sources such as wetlands. Do not spread manure within 200 feet of a water source unless it can *immediately* be incorporated into the soil. *Avoid manure application on land subject to annual flooding, especially during flood prone periods.*
- **Incorporation**- Manure incorporated into soil is less prone to run-off than if it remains on the surface. Incorporate manure into the soil within 72 hours of application. *This is particularly important on slopes, near water bodies and during wet seasons.*

Test Soil and Manure

- Soil testing helps a farmer to decide what the nutrient needs are for the crop.
- Manure testing shows levels of nutrients in the manure.

By comparing the results of both tests, farmers can apply the right amount of manure. *Never apply more nutrients than needed – this is the first step in reducing nutrient run-off.*

Create a Composting site - By composting manure and other organic materials the farmer produces an excellent soil conditioner.

- Composting shrinks the weight and volume of manure and simplifies handling.
- Composting decreases odors and reduces the amount of pathogens.

Install and Maintain Buffer Areas. Riparian buffer zones are vegetated areas between streams or rivers and crop or pastureland. These forests and grasses act as living filters by absorbing nutrient and chemical run-off.

STRUCTURAL

Store manure properly - Manure should be stored in properly located and constructed facilities. The storage facility should be:

- Covered, contained, and impermeable to prevent runoff or leaching to the ground
- Have the capacity to hold a minimum of 3-6 months of manure.

Control Barnyard Run-off - Run-off from poorly managed barnyards and feedlots can carry pathogens, nutrients and oxygen-demanding substances into water sources.

- Shape barnyards by grading or filling so that run-off can be directed to a controlled outlet such as a *Settling Basin*
- *Grass Filter Strips* absorb nutrients from run-off reducing threats to surface waters

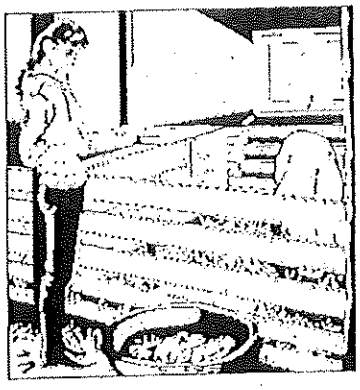
Install Fencing - For safety, livestock standing, feeding, and grazing areas are prohibited within 100 feet of drinking water reservoirs and their tributary streams. Construct barriers that prevent livestock or wildlife from accessing water sources. The farmer may need to bring water to livestock rather than livestock to water.

Construct Stream Crossings - Trampled stream banks erode easily allowing manure and sediments into surface waters. Limit the amount of access livestock have to stream banks by directing them over constructed stream crossings.

Build Diversions and Terraces - Divert run-off from critical areas using these channeled ridges or earthen embankments constructed perpendicular to slopes.

Install Grassed Waterways – Natural or constructed vegetated channels which filter and divert run off away from water resources.

Use a Conservation Plan - Farm operators should have a conservation plan designed to optimize crop yield and minimize effects on ground and surface water. This plan could include many of the guidelines described in this fact sheet.



Any questions or concerns about manure use should be directed to:

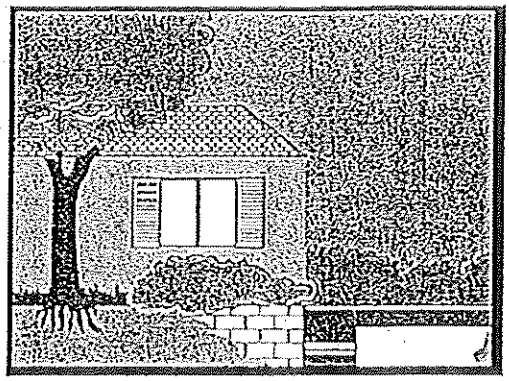
The Farm Products and Plant Industries at the Massachusetts Department of Food and Agriculture (DFA), 251 Causeway Street, Boston, MA 02114. Telephone: 617-626-1700. Website: www.massdfa.org

For additional information on Best Management Practices, developing a conservation plan, or creating a composting site, call your local United States Department of Agriculture Conservation Service office or contact the Massachusetts Department of Food and Agriculture at 617-626-1700 or access their web site at www.massdfa.org. Funding for incorporating BMP's to a farm is available through both the USDA and MFDA.

PUBLIC EDUCATION MATERIALS:
SURFACE WATER PROTECTION

Your Septic System

A Reference Guide for Homeowners



Caring for Your Septic System

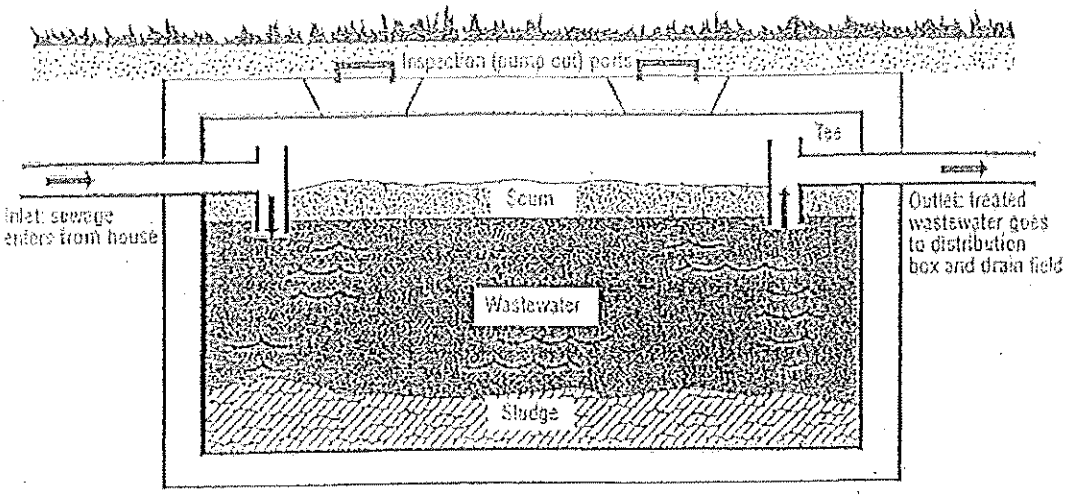
The accumulated solids in the bottom of the septic tank should be pumped out every three to five years to prolong the life of your system. Septic systems must be maintained regularly to stay working.

Neglect or abuse of your septic system can cause it to fail. Failing septic systems can

- cause a serious health threat to your family and neighbors,
- degrade the environment, especially lakes, streams and groundwater,
- reduce the value of your property,
- be very expensive to repair,
- and, put thousand of water supply users at risk if you live in a public water supply watershed and fail to maintain your system.

Be alert to these warning signs of a failing system:

- sewage surfacing over the drainfield (especially after storms),
- sewage back-ups in the house,
- lush, green growth over the drainfield,
- slow draining toilets or drains,
- sewage odors.



Tips to Avoid Trouble

DO have your tank pumped out and system inspected every 3 to 5 years by a licensed septic contractor (listed in the yellow pages).

DO keep a record of pumping, inspections, and other maintenance. Use the back page of this brochure to record maintenance dates.

DO practice water conservation. Repair dripping faucets and leaking toilets, run washing machines and dishwashers only when full, avoid long showers, and use water-saving features in faucets, shower heads and toilets.

DO learn the location of your septic system and drainfield. Keep a sketch of it handy for service visits. If your system has a flow diversion valve, learn its location, and turn it once a year. Flow diverters can add many years to the life of your system.

DO divert roof drains and surface water from driveways and hillsides away from the septic system. Keep sump pumps and house footing drains away from the septic system as well.

DO take leftover hazardous household chemicals to your approved hazardous waste collection center for disposal. Use bleach, disinfectants, and drain and toilet bowl cleaners sparingly and in accordance with product labels.

DON'T allow anyone to drive or park over any part of the system. The area over the drainfield should be left undisturbed with only a mowed grass cover. Roots from nearby trees or shrubs may clog and damage your drain lines.

DON'T make or allow repairs to your septic system without obtaining the required health department permit. Use professional licensed septic contractors when needed.

DON'T use commercial septic tank additives. These products usually do not help and some may hurt your system in the long run.

DON'T use your toilet as a trash can by dumping nondegradables down your

toilet or drains. Also, don't poison your septic system and the groundwater by pouring harmful chemicals down the drain. They can kill the beneficial bacteria that treat your wastewater. Keep the following materials out of your septic system:

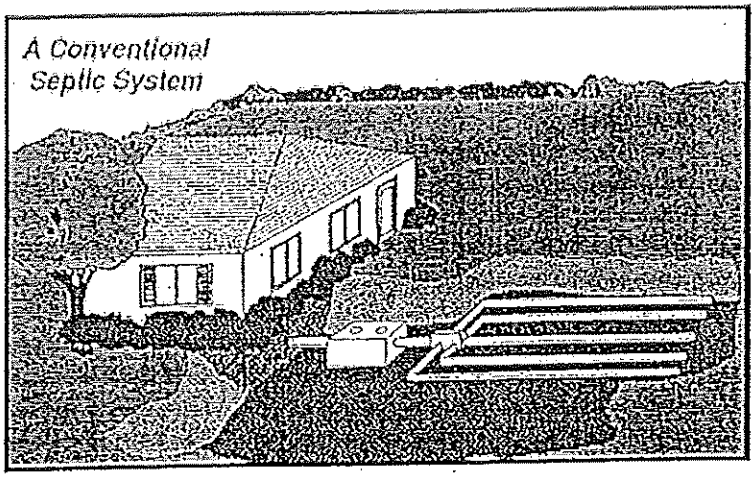
NONDEGRADABLES:
grease, disposable diapers, plastics, etc.

POISONS:
gasoline, oil, paint, paint thinner, pesticides, antifreeze, etc.

Septic System Explained

Septic systems are individual wastewater treatment systems that use the soil to treat small wastewater flows, usually from individual homes. They are typically used in rural or large lot settings where centralized wastewater treatment is impractical.

There are many types of septic systems in use today. While all septic systems are individually designed for each site, most septic systems are based on the same principles.



A Conventional Septic System

A septic system consists of a septic tank, a distribution box and a drainfield, all connected by pipes, called conveyance lines.

Your septic system treats your household wastewater by temporarily holding it in the septic tank where heavy solids and lighter scum are allowed to separate from the wastewater. This separation process is known as primary treatment. The solids stored in the tank are decomposed by bacteria and later removed, along with the lighter scum, by a professional septic tank pumper.

After partially treated wastewater leaves the tank, it flows into a distribution box, which separates this flow evenly into a network of drainfield trenches. Drainage holes at the bottom of each line allow the wastewater to drain into gravel trenches for temporary storage. This effluent then slowly seeps into the

subsurface soil where it is further treated and purified (secondary treatment). A properly functioning septic system does not pollute the groundwater.

For More Information

A videotape version of this brochure, also entitled "Your Septic System: A Guide for Homeowners", is available through the EPA Small Flows Clearinghouse. Call 1-800-624-8301.

For more information about maintenance or inspection of your septic system, contact your local board of health or the Department of Environmental Protection:

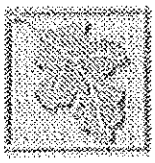
Central Regional Office (508) 792-7650
Northeast Regional Office (978) 6617677
Southeast Regional Office (508) 946-2700
Western Regional Office (413) 784-1100
Boston Office (617) 292-5673

[Contact: Douglas.Roth@state.ma.us]

[Bureau of Resource Protection Publications] [Consumer Information]
[Bureau of Resource Protection Home] [DEP Publications] [DEP Home]

Revised February 2002

Privacy Policy



Consumer Protection Tips: Septic System Inspections and Repairs

Across the Commonwealth of Massachusetts, failing septic systems and cesspools are a major cause of contaminated drinking water, tainted shellfish beds and polluted beaches. Title 5 of the State Environmental Code protects you, your family and your neighbors from these public health threats by requiring inspection of private sewage disposal systems before the sale, expansion or change in use of properties where they are present. Inspection results are reported to local boards of health. Most systems will pass inspection. Systems that fail must be repaired or upgraded.

If you own a home with a septic system or cesspool and have plans to put it up for sale, add a bedroom or convert it to a different use, you will need to have your system inspected - and possibly fixed or replaced. This brochure is intended to help you make the right decisions about who to hire and how to finance repairs if they are necessary.

You'd Better Shop Around

When you need to hire a system inspector, there are two important things you need to bear in mind. First, inspection fees are not regulated by the Department of Environmental Protection or anyone else. Inspectors can charge whatever their customers are willing to pay. The fee also may vary depending on the complexity of the inspection. Second, only certain professionals are qualified to perform Title 5 system inspections:

- Professionals who meet experience requirements and have passed a DEP- administered exam;
- Registered Sanitarians;
- Certified Health Officers; and
- Registered Professional Engineers who specialize in civil, environmental or sanitary engineering.

For a list of qualified system inspectors in your area, contact your local board of health or call DEP's Title 5 Hotline at (617) 292-5886 or 1-800-266-1122.

But before hiring anyone, do some comparison shopping:

- Get written estimates from several inspectors. One key question to ask is whether the price of the inspection includes pumping

the system; often it does not.
- Ask for and check each inspector's identification and references.
- Before signing any contract, be absolutely certain that it spells out precisely what work is going to be done, how much it is going to cost, what the payment terms are, and what, if any, guarantees the inspector is willing to provide.
- And, once the inspection is complete, make sure the person who signs the form is the same person who conducted the inspection.

What To do If Your System Fails

If your septic system or cesspool fails inspection, Title 5 allows up to two years for the completion of repairs or an upgrade. The first thing you should do is contact your local board of health, which needs to approve all upgrades and most repairs, and can tell you that will be required.

Again, shop around. Get written estimates, check qualifications and references. Remember that you are under no obligation to have the person who inspects your system perform any other work on it. In fact, you may want to hire separate contractors. While most septic system professionals are honest business people, as in any other profession there may be a few "bad apples" who try to take advantage of the consumer. If you ever believe you have been treated unfairly by a system inspector, soil evaluator, engineer, or system installer, call the Massachusetts Environmental Strike Force at (617) 556-1000.

Repair or upgrade costs will vary depending on the nature of the problem, soil conditions, proximity of the system to water supplies, and the size of the lot. Title 5 does not specify who must pay for the system inspections, repairs or upgrades. Keep that in mind if you are planning to sell your home. You may find during negotiations that the prospective buyer is willing to assume some or all of the costs. Just be sure to consult with a lawyer or mortgage lender who is familiar with Title 5 before shaking hands on the deal.

Even if you have no plans to move, you may qualify for one or more programs designed to help homeowners pay for septic system or cesspool repair or replacement:

- Many cities and towns either have in place now or are working to establish "betterment" loan programs to provide homeowners with long-term, low-cost financing;
- The Massachusetts Housing Finance Agency (MHFA) and Federal Farmers Home Administration (FHA) offer low-cost financing to those who qualify;
- Pending state legislation would provide for septic system repair tax credit of up to $2,500 per homeowner.

For additional information, contact your local board of health; MHFA at 617/854- 1000; FHA at U.S. Department of Agriculture, Washington, DC 20250; or your state legislator.

Protect Your Investment

One of the best ways to ensure that your septic system or cesspool will pass inspection is to keep it on a routine maintenance schedule. At a minimum, you should have it pumped out every three years. If you use a garbage disposal, annual pumping is a must.

And a word about septic system additives: There isn't one on the market that can make a failing system pass inspection. DEP approves septic system additives, but only to ensure that they will not harm your system or the environment. DEP does not evaluate the accuracy of claims manufacturers make about the effects their products will have on system performance.

Remember, that even the best-maintained system in the world cannot last forever. Like anything else, it will wear our over time, stop working properly and need to be repaired or replaced.

Need More Information?

If you still have questions about getting your septic system or cesspool inspected, repaired or upgraded, please contact DEP's Title 5 Hotline at (617) 292-5886 or 1-800-266-1122.

Massachusetts Department of ENVIRONMENTAL PROTECTION

fact sheet

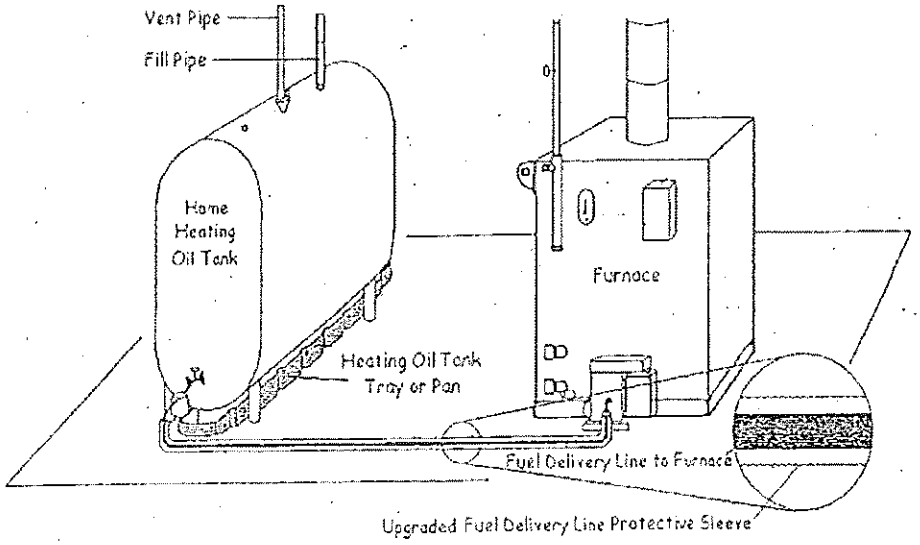
Tips For Maintaining Your Home Heating System: Prevent Heating Oil Leaks and Spills

Cleaning up oil leaks from home heating systems can be very expensive. The average cost can range between $20,000 and $50,000, with some cleanups costing significantly more. Here are some ways to save money, help prevent leaks and spills, and protect the environment.

For all heating oil systems:

- Annually:
  - Inspect for leaks. Look at the tank, fuel delivery line, valves, piping, and fittings.
  - Have your oil company:
    - ✓ Clean the furnace and repair or replace damaged parts. A well-maintained furnace means lower fuel bills and cleaner emissions.
    - ✓ Install an oil safety valve or replace the fuel delivery line with one encased in a protective sleeve. These are inexpensive upgrades. Contact the fire department to determine if a permit is required for this work.
  - Each fall, inspect the vent pipe to ensure that it is free of obstructions and that an audible signal (whistle) is on the vent. Oil company personnel listen for the whistle to help avoid overfills, a common source of spills.
- At least every 10 years, have the oil tank cleaned out. Over time, water (from condensation) and sludge can cause corrosion resulting in leaks.
- When appropriate:
  - Remove abandoned fill and vent pipes immediately.
  - Clearly mark the location of the tank's fill pipe.
  - Consider upgrading to a modern, fuel-efficient furnace.

Typical Above-Ground Home Heating Oil System



For underground tanks:

- Determine if the underground storage tank is made of steel (common) or fiberglass (rare). Most steel underground storage tanks will last approximately 10 to 20 years. If the tank is older than that or the age is unknown, replace it with an above-ground storage tank. Locate your new tank under a shelter, or inside a basement or garage, to prevent rust, corrosion, or damage.

For outdoor above-ground tanks:

- Ask your oil company to inspect the stability of the above-ground tank. A full 275-gallon tank weighs more than 2,000 pounds! They have metal legs and should sit on a concrete pad. If the legs become loose or the pad cracks, the tank can fall over and rupture.
- Replace an outdoor above-ground storage tank that has been uncovered for 10 years or longer. These tanks rust from the inside out, so cleaning or painting the outside does not usually prolong their life.
- Protect the tank from the weather, such as falling snow and ice, and prevent ruptures by tree limbs.

For indoor above-ground tanks:

- Inspect indoor above-ground storage tanks for signs of pitting and corrosion, particularly at the bottom of the tank. Tanks primarily rust from the inside out, so if signs of aging are present, replace the tank. Indoor tanks do not last more than about 30 years, and often their lifespan is much shorter.
- Consider placing a plastic heating oil tray or pan under the tank. This makes it easier to keep the tank area clean and help identify and contain small leaks.

If your oil company offers to perform a "tightness test," ask if this could cause a problem. Generally, these tests should NOT be performed on older residential heating oil systems. Because of the pressure used during a tightness test, older equipment can fail, causing a leak or spill. If you have a tank, fuel delivery line, valves, piping, and fittings on which it is inadvisable to perform a tightness test because of age or condition, then it is probably better to replace the equipment that is causing the concern.

Visit our Web site or call for more information. Access DEP's Web site at http://www.mass.gov/dep/bwsc/facts.htm to review related documents, including "Heating Oil Delivery Lines" (http://www.mass.gov/dep/bwsc/files/deline.htm), or call the DEP Helpline (617-338-2255 or 800-462-0444) and select option 2.

If you suspect an oil leak or spill, immediately contact your oil company and fire department for assistance. Leaks or spills of 10 gallons or more must be reported to DEP within 2 hours. To report a leak or spill, call DEP (within 2 hours) and the fire department.

DEP's 24-hour statewide emergency response number is 888-304-1133.

Massachusetts Department of Environmental Protection
One Winter Street
Boston, MA 02108-4746

Commonwealth of Massachusetts
Jane Swift, Governor

Executive Office of Environmental Affairs
Bob Durand, Secretary

Department of Environmental Protection
Lauren A. Liss, Commissioner

Produced by the Bureau of Waste Site Cleanup, January 2002.
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This information is available in alternate format by calling our ADA Coordinator at (617) 574-6872.

waste site cleanup

Prevention - Worth Many Pounds of Cure!

No where is the old adage about prevention more relevant. If you have not yet experienced a problem, or even if you have, you might want to consider the following advice about common situations, to avoid (or avoid repeating) future problems.

Fuel Oil Storage Tanks

Here's what you should do for the number one contamination problem among homeowners and small businesses:

- *Replace or Upgrade Buried Tanks* - The average period of time an unprotected steel tank can be buried in the ground before springing a leak is only about 15 years. This is only a rough rule of thumb; depending on site conditions and tank design and construction, any given tank may experience failure much sooner or much later than this average value. Eventually, however, all tanks can leak, and the costs to clean up the mess could easily run into 5 figures. So, as soon as you can, plan on replacing an old buried tank, either with a modern corrosion-resistant/protected tank, or better yet, by installation of a free-standing/above-ground tank. For more details, please refer back to the main Homeowners Web Page to download documents including *Removing Your Underground Heating Oil Tank - A Homeowners Guide* (1996), the DEP draft publication *Assessing Contamination at Residential Underground Heating Oil Tank Closures,* and other homeowner and small property owner material.

- *Replace Old/Rusted Free-Standing Tanks* - If you have an old, rusted free-standing oil tank in your basement, ask your oil dealer about whether it should be replaced. The Bureau of Waste Site Cleanup (BWSC) responds to a number of spills where the use of new high-flow fuel oil delivery systems "blows out" the ends of weaker tanks.

- *Replace Your Oil Supply Delivery line* - By code, the oil tank in your basement has to be a certain distance from your furnace. Oil is transferred from the tank to the furnace by means of a delivery line.

These lines are typically small-diameter copper tubing, and are usually buried below the concrete basement floor. Unfortunately, the corrosive nature of concrete tends to create holes in these lines, which could lead to the (substantial) leakage of oil into the soil below the basement floor. Often, this can occur for years without being noticed. Eventually, the oil may surface in a basement sump, storm drain, or neighboring drinking water well. Talk to your oil dealer about replacing these lines with more modern, corrosion-resistant, double-walled piping systems. This can usually be done for a modest price, and is one of the best insurance policies your can buy for pollution prevention!

- *Remove Old /Unused Fill and Vent Pipes* - On occasion, an oil tank in a basement is removed, but the fill pipe (through the exterior wall) is left in place. Periodically, BWSC responds to spills where an oil delivery was mistakenly made to one of these disconnected fill and vent pipes - and where oil was pumped directly into a basement! If the tank is removed, immediately remove the fill and vent pipes. If the tank is unused, take steps to lock or secure the fill and vent pipes, to prevent accidental deliveries.

Septic Systems

Septic systems, and especially cesspools and drywells, are direct routes to the environment. NEVER discharge gasoline, oils or chemicals into these systems. Not only is this illegal, but it has the potential to contaminate soil and groundwater, and create a "hazardous waste" site that will be very costly to clean up. Of particular concern are chlorinated solvents, like trichloroethylene (TCE), trichloroethane (TCE) or perchloroethylene ("perc") - some of which were in the past marketed as drain cleaners. These chemicals are heavier than water, and will "sink" if discharged to the groundwater. They are also resistant to biological breakdown, and can travel great distances (up to a mile or more) in the groundwater. BWSC is aware of a number of neighborhood communities where private drinking water wells have been impacted (or shut down) because of contamination that likely came from septic system/dry well discharges.

Asbestos

In many older homes, asbestos-containing materials were used for insulation of furnace/stove piping and associated ductwork. In some homes, asbestos-containing cementious siding materials and shingles were used. In either case, the inappropriate removal and disposal of these materials could expose you or your neighbors to cancer-causing asbestos fibers. For that reason, there are strict regulations on how these materials must be handled, and where they can go. Contact the appropriate DEP Service Center for more information and details if you are planning renovations that will involve disturbance or removal of these materials. Note that the unpermitted removal and disposal of asbestos materials is not only illegal, but may also result in the creation of a "hazardous waste" site that would fall under the jurisdiction of MGL c. 21E and the Massachusetts Contingency Plan - and necessitate an

expensive cleanup.

Lead In Soils

Lead poisoning is one of the top environmental health threats to children. Over time, exposure to even low levels of lead can affect a child's growth, behavior, and learning ability. Children under six years of age are particularly vulnerable to lead poisoning. For more information click *leadcon1.htm*.

Return to the main homeowners web page.

Removing Your

Underground Heating Oil Tank

Summer 1998

A Homeowner's Guide

If your home heating oil storage tank is buried underground, you probably know already that a leak could be very unfortunate - not only for the environment, but for your pocketbook. When an underground storage tank or connected piping leaks, the cleanup can be costly. And if your homeowners insurance policy contains a "pollution exclusion" clause, which many do, you could get stuck with the bill.

The best way to avoid significant expenses later is to have your tank taken out of the ground now and have a new tank installed in your basement, garage or storage shed. You probably have questions about what this would involve. This guide has been prepared by The Massachusetts Department of Environmental Protection (DEP) and the Department of Public Safety (DPS) to give you answers and advice.

DFS regulates the installation, maintenance and removal of underground tanks. The agency relies primarily upon the local fire departments to ensure that this work is done in accordance with the law. For tank removals, local fire officials issue the necessary permits, determine when conditions are safe for excavation, and respond to emergencies or public safety hazards. They also ensure that measurements are made for contamination when the tanks are removed.

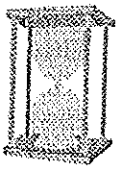
When tanks are found to be leaking, additional work is usually needed to determine the extent of the problem and whether cleanup will be required. Contamination should be reported to the local fire department and, in some instances, to DEP.

State law does not require the removal of a residential underground tank if it isn't leaking, but there may be local requirements in your community. Check with your fire department or health board.

Why should I consider removing my underground storage tank?

Many underground home heating oil tanks are the same type of 275 gallon bare steel tanks you have probably seen in basements or garages. These tanks were not designed to be buried and, if left in place, will eventually rust and leak. Even larger tanks that were specifically designed for underground use can leak if they do not have adequate corrosion protection.

If you notice an unexplainable sharp increase in your home heating oil consumption, your tank may be leaking. But that information alone is not always an accurate indicator. In some cases, leaks are found even after homeowners see their oil consumption drop.



While your underground tank probably is not leaking yet, the odds of a leak happening increase as the tank gets older. Even small, slow leaks can pose serious threats to your family, your neighbors and the environment if they go undiscovered for a long time. And, if your tank does leak, you may face a costly cleanup. Having your underground storage tank removed now can save you both money and anguish in the long run.

How much does an underground tank removal cost?

Removal contractors generally charge between $500 and $2,500 depending on the size of the tank, its condition, and how easily it can be reached. The checklist on pages 3 and 4 of this guide includes a summary of services that your contractor should provide for this price. Usually not included in this price are the cost of a replacement tank, sampling and testing, cleanup work if a leak is found, and landscaping after the removal is complete.

For the best price, shop around and get cost estimates from your oil company, if it does removals, as well as from several contractors. They can provide you with an accurate cost estimate only by visiting your home to determine both where your tank is located and whether there are any

obstacles to getting the job done. Compare services the companies can provide and be sure to check references. As with any substantial home improvement job, get a written cost estimate and a contract that outlines the services to be performed before work begins.

Can I test my tank for leaks instead of digging it up?

Yes, but it may cost you less to simply remove your tank from the ground. It is important to consider that no test can predict what will happen next year, next month, or even the next day. Your money may be better spent on tank removal since you will have to dig the tank up anyway if the test reveals it is leaking. Information on testing methods can be obtained from your local fire department, DFS (at (978) 567-3300) or companies that perform tank tests.

Can I just empty the oil from my tank and leave it underground?

Yes - but only in limited conditions and only if your local fire department approves. Typically, leaving a tank in place will be allowed only if its removal will jeopardize the structural integrity of your home. Even if the fire department lets you leave your tank in place, you will need to have it cleaned and filled with sand or concrete, and the area around it checked for contamination.

Getting this done will cost about the same as having your tank removed from the ground. In addition, should you decide to sell your home, a bank or the buyer may ask for more environmental testing or the removal of the tank, which could make leaving your tank in place costlier than taking it out of the ground at the start.

How will I know if my tank has leaked?

Contamination may be indicated by signs of a damaged tank or piping, soil that is stained or gives off strong oil odors, a sheen on the groundwater, or environmental test results. Under state law, a measurement for contamination is required within 24 hours of a tank removal. So before work even begins, make sure the contractor has the necessary expertise to make such a measurement.

The accompanying checklist includes an outline of the steps that need to be taken to measure for contamination. The basic inspection is a sight, smell and physical check of the tank and the surrounding soil. Sampling and analysis is recommended if the tank is located near any wells, drinking water supplies, wetlands, ponds or streams, or if there are any indications that contamination is present.

What if contamination is found?

First, don't panic. The problem could be minor and relatively simple to correct. Simply remember the importance of notifying the proper officials and taking the appropriate cleanup actions right away. Addressing the problem now will prevent unnecessary cost and damage later.

If you find contamination or even suspect there has been a leak, contact the nearest DEP regional office (the telephone numbers can be found on page 4 of this guide). Also notify your local fire department, which will help you and your contractor determine what needs to be done next. While not all leaks must be reported to DEP, it is recommended that you contact the agency for help in determining whether the level of contamination found makes reporting necessary in your individual case and what next steps are necessary.

For additional information, contact your local fire department or your nearest DEP regional office.

☑ Tank Removal Checklist

STEP 1 - DO YOUR HOMEWORK

Ask your local fire prevention officer about...

- ☑ Any local rules that may be more stringent than what state law requires; and
- ☑ Requirements for measuring for the presence of contamination.

STEP 2 - HIRE A CONTRACTOR

Shop around...

- ☑ Seek tank removal company referrals from your...
  - Oil company;
  - Local public works department;
  - Neighbors;
  - Yellow Pages directory (look under Oil Tanks or Tank Services);
  - Local fire department; or
  - The Massachusetts Oilheat Council at (617) 237-0730.
- ☑ Compare costs (prices are higher for removals of tanks that are large or difficult to reach);
- ☑ Compare services (the basic services a contractor should provide are listed in STEP 3 below);
- ☑ Check references; and
- ☑ Ask your oil company if it will credit you for any usable fuel that is removed from your tank.

Make sure the contractor you select...

- ☑ Understands the state regulations (527 CMR 9.00, 502 CMR 3.00) and any local rules governing underground tank removals;
- ☑ Is able to inspect the tank and identify possible signs of contamination;
- ☑ Provides a written contract with a specific cost estimate based on property conditions; and
- ☑ Is insured to perform such work.

STEP 3 - THE TANK REMOVAL

Your removal contractor should...

- ☑ Obtain all required permits;
- ☑ Empty oil from the tank and clean out all residues or arrange for someone else to perform this work;
- ☑ Excavate the tank and piping;
- ☑ Dispose of the tank, piping, residues, soil and any remaining oil at locations that are authorized to accept them;
- ☑ Check for signs of a leak and report findings to you (see STEP 4);
- ☑ Separate clean soil from any that appears to be contaminated;
- ☑ Backfill the hole to grade; and
- ☑ Provide written documentation of the removal, including disposal or recycling records for the tank, fuel, residues, and contaminated soil (if any).

Your local fire department should....

- ☑ Observe the removal;
- ☑ Ensure that the tank and surrounding area are free of safety hazards;
- ☑ Ensure that a measurement for contamination is made; and
- ☑ Note on the removal permit both the condition of the tank and whether any contamination was observed.

You should...

- ☑ Observe the tank removal from a safe distance;
- ☑ Record any problems that are encountered by the contractor; and
- ☑ Take notes and photos to document the work, even if everything seems to be going well.

STEP 4 - THE CONTAMINATION MEASUREMENT

State law requires that a measurement for contamination be taken within 24 hours of the time a
tank is either removed from the ground or cleaned, filled and left in place. The measurement can be performed by the tank contractor or an environmental professional. You should observe the inspection and obtain written observations from people at the scene, including the contractor and fire officials, even if the tank and piping appear sound and there are no signs of contamination.

The basic measurement includes...

- Recording the condition of the tank, piping, and soil;
- Checking the tank and piping for holes;
- Examining the feedline and soil surrounding it;
- Checking the excavated area for visible oil stains or strong odors;
- Noting problem areas on a drawing or map of the excavation;
- Photographing the area to support written documentation;
- Taking a composite soil sample to be analyzed for petroleum constituents if:
  (a) The condition of the tank, piping, or soil indicates a leak may have occurred;
  (b) Your tank is located near a well, water supply, wetland, pond, or stream; or
  (c) You want a record of analytical results to confirm that no contamination was found.

The local fire department will specify the procedures for taking the contamination measurement when a tank is to be cleaned, filled and left in the ground.

STEP 5 (if necessary) - REPORT LEAKS OR SPILLS

State law requires that you report certain petroleum releases or threats of release to DEP and the local fire department (depending on the nature and volume of the release, as well as contamination levels). DEP can help you in determining whether a particular situation requires reporting. Should any contamination be observed during the removal of your tank, contact the fire department (as well as the board of health if required by local ordinance) and notify the DEP regional office nearest you :

Springfield	**(413) 784-1100**
Worcester	**(508) 792-7653**
Woburn	**(617) 932-7681**
Lakeville	**(508) 946-2850**

- Consult with local and DEP officials before proceeding with any further cleanup work. In most cases, the tank removal will not have to be halted.
- Do not, under any circumstances, allow your contractor to excavate to a point where the structure of your home is compromised.
- Any soil suspected of being contaminated should be separated from soil that appears to be clean (so you will not be paying for the disposal of clean soil).
- If needed, hire an environmental consultant to ensure proper assessment and cleanup. DEP can advise you on whether this is necessary.
- Check with your insurance agent to see if you are covered in the event of an oil spill or leak at your home.

STEP 6 - KEEP GOOD RECORDS

It is important to maintain complete records of the tank removal, inspection process, and any necessary cleanup work. Keep them in a safe place with your other important records. You may be asked to produce them later if you sell your property, obtain financing, or file an insurance claim. Your documentation should include:

- Shipping records documenting recycling or disposal of the tank, piping, residues, soil, and fuel;
- An accurate drawing showing where the tank was located;
- Contamination measurement results, including any analytical results, if samples are taken;
- Documentation of any cleanup work, if performed;
- Your own notes and photos taken during the removal, inspection and cleanup (if necessary); and
- Written observations from people at the scene, including the contractor and fire officials.

The Commonwealth of Massachusetts
William F. Weld, Governor
Argeo Paul Cellucci, Lt. Governor
Executive Office of Environmental Affairs
Trudy Coxe, Secretary
Department of Environmental Protection
David B. Struhs, Commissioner
Executive Office of Public Safety
Kathleen O'Toole, Secretary
Department of Public Safety
Winthrop Farwell, Commissioner

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Massachusetts Department of ENVIRONMENTAL PROTECTION

fact sheet

How Can I Protect Drinking Water Sources?

Businesses Protect Drinking Water

Best Management Practices (BMPs) can help to protect drinking water from contamination by materials used in daily business operations. Concerns include the improper handling, storage, or disposal of cleaning solvents, fuel, motor oil, used batteries, machinery parts, leaks from underground storage tanks, detergents, fertilizers and pesticides, de-icing chemicals, medical wastes, paints, and other hazardous chemicals and wastes.

Hazardous Materials

- ✓ Use BMPs for proper hazardous material handling, storage, disposal, and emergency response planning.
- ✓ If your business is currently an unregistered generator of hazardous waste or waste oil, register with the Department of Environmental Protection (DEP). Refer to the Requirements for Small Quantity Hazardous Waste Generators at: http://www.mass.gov/dep/bwp/dhm/files/sqgsum.pdf.
- ✓ Upgrade all above and below ground oil/hazardous material storage tanks to meet current construction standards. Funding for replacing underground storage tanks is available through the MA Department of Revenue. For more information, refer to http://www.dor.state.ma.us/ust/ust_home.htm.

Floor Drains

Floor drains connected to dry wells or septic systems provide a route directly to groundwater if leaks or spills occur. In some cases floor drains may discharge to storm sewers or directly to surface waters.

- ✓ Investigate where floor drains flow. If floor drains do not flow to a tight tank or municipal sewer, comply with DEP UIC requirements. For more information, refer to http://www.mass.gov/dep/brp/dws/dwspubs.htm#uic.
- ✓ Floor drains in areas where hazardous materials or wastes are stored must drain to a tight tank, be sealed, or be connected to a municipal sanitary sewer. See also http://www.mass.gov/dep/brp/dws/files/uic.pdf for more information.

Septic Systems

- ✓ Do not dispose of any hazardous materials such as cleaners, paints, or oil to a septic system. Septic systems drain to the soil without treatment.
- ✓ Locate, inspect, and maintain septic system components regularly to ensure a working septic system. See also http://www.mass.gov/dep/brp/files/yoursyst.htm.

Lawncare and Landscaping

- ✓ Incorporate best management practices for the application, storage, and disposal of fertilizer, herbicides and pesticides. Refer to http://www.massdfa.org/pesticides/publications/IPM_kit_for_bldg_mgrs.pdf.

For More Information

For additional help regarding environmental requirements and BMPs, contact the Office of Technical Assistance (OTA). The OTA is a non-regulatory agency within the Commonwealth's Executive Office of Environmental Affairs. OTA provides free, confidential assistance at http://www.mass.gov/ota/.

ssachusetts Department of Environmental Protection
One Winter Street
Boston, MA 02108-4746

Commonwealth of Massachusetts
Jane Swift, Governor

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Bob Durand, Secretary

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uren A. Liss, Commissioner

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ADA Coordinator at

Massachusetts Department of ENVIRONMENTAL PROTECTION

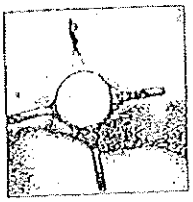
fact sheet

How can I protect drinking water sources?

Residents Protect Drinking Water

Household Hazardous Waste

- ✓ Participate in Household Hazardous Waste Collection days or centers for used oil, antifreeze, paints, and other chemical disposal.
- ✓ Substitute less hazardous substances for products used in the home. See also http://www.mass.gov/dep/recycle/hproduct.htm

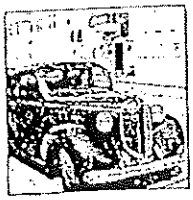


Septic systems

- ✓ Never dispose of household hazardous waste to your septic system.
- ✓ Prevent failed septic systems by locating system components, maintaining, and inspecting your system regularly. See also www.mass.gov/dep/brp/files/yoursyst.htm.

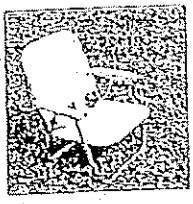
Underground and Aboveground Storage Tanks

- ✓ Upgrade fuel oil tanks to include proper containment and safety measures. Consult with the fire department before making changes, as any changes must comply with plumbing, building, and fire codes.
- ✓ Catch costly leaks by inspecting fuel lines and keeping a fuel log.



Car Care

- ✓ Check your car for oil leaks, and repair leaks quickly.
- ✓ Dispose of waste oil properly, never in drains or on the ground. Recycle oil at a car care center or hazardous waste center. See also www.epa.gov/region01/eco/lis/posters/oil.html.



Lawn Care and Landscaping

- ✓ Apply pesticides and fertilizers minimally and properly. More information on environmentally sound lawn care is available at www.massdfa.org/pesticides/publications/index.htm and www.epa.gov/region01/eco/lis/posters/lawn.html

Pet Waste

- ✓ Don't walk your pet near wells or reservoirs. Encourage the creation of pet waste stations for waste disposal in parks.
- ✓ Practice proper pet waste disposal, picking up after your pet and preferably flushing waste, or disposing of waste in the garbage. See also www.epa.gov/region01/eco/lis/posters/pet.html

Do you already do all of this and want to do more to protect your drinking water? Contact your local water supplier to volunteer.

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Massachusetts Department of ENVIRONMENTAL PROTECTION

fact sheet

How can I protect drinking water sources?

Water Suppliers Protect Drinking Water

Groundwater

Groundwater Source Protection

- ✓ Inspect Zone I areas frequently for illegal dumping or other prohibited activities.
- ✓ Post signs around the Zone I to involve the community in protecting the areas closest to drinking water sources. Fence the area to prevent unwanted access.
- ✓ Bring non-conforming Zone Is in to compliance by relocating non-water supply related land uses, especially septic systems and fuel oil tanks. Funding information is available at http://www.mass.gov/dep/brp/dws/grants/.
- ✓ Store water supply chemicals properly, ensure secondary containment is always used to capture any leaks or spills within the Zone I.
- ✓ Use propane or natural gas for backup power.
- ✓ Identify any floordrains in your protection areas and ensure their compliance with DEP Underground Injection Control regulations to prevent them from becoming a route for contamination to the groundwater.

Water Supply Planning

- ✓ Develop a Wellhead Protection Plan. For more information, see "Developing a Wellhead Protection Plan" at http://www.mass.gov/dep/brp/dws/files/whpguide.pdf.
- ✓ Consider future water supply needs in your long-term and short-term planning. The sample Water Supply Business Plan is available on the web at http://www.mass.gov/dep/brp/dws/files/busplan.doc.
- ✓ Have an up-to-date Contingency Plan for providing adequate water in the event of temporary shortages.
- ✓ Have a current Emergency Response Plan. Assess the potential for releases at various points, develop communication protocols, specify spill response measures, and train water supply staff. An up-to-date emergency response handbook is available at http://www.mass.gov/dep/brp/dws/dwspubs.htm
- ✓ Develop a Land Acquisition Plan. Acquire land in your water supply protection areas, especially in the areas closest to your sources. Acquisitions can be accomplished by municipal and non-municipal water systems through conservation restrictions, land banking, land purchases and land donation. Sample conservation restrictions are available at: http://www.mass.gov/dep/brp/dws/.

Cooperation with Local Authorities

- ✓ Work with municipal planners to ensure they include you in the site plan review process on any developments in the Zone II. Take the opportunity to address water supply concerns at the initial stages of development.
- ✓ Work with the local Board of Health to target inspection of facilities within your Zone IIs.

Education

- ✓ Provide information to residents, businesses and planners on how they can help to protect local drinking water sources and the locations of your Zone IIs. Fact sheets on protection are available at http://www.mass.gov/dep/brp/dws/.

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How can I protect drinking water sources?

Planners Protect Drinking Water

Wellhead Protection Planning

- ✓ Create a Wellhead Protection Plan. Many of the following recommendations are part of such a protection plan, with further information listed in "Developing a Local Wellhead Protection Plan" at http://www.mass.gov/dep/brp/dws/files/whplan.doc.
- ✓ Monitor land uses within and near the Zone II by working with the Building Inspector, Board of Health and Planning Board. Refer to the Wellhead Protection Plan guidance and model bylaws for types of activities that should be prohibited and managed in the vicinity of water supplies.

Municipal Controls

- ✓ Adopt and implement municipal controls for wellhead protection that comply with 310 CMR 22.21(2). These controls restrict land uses of concern within the Zone IIs.
- ✓ Control hazardous materials by adopting a bylaw or health regulation to require proper storage, handling, and disposal of hazardous materials. Include permanent collection centers for household wastes, such as used motor oil, batteries, paints, and cleaners.
- ✓ Control floor drains and prevent contaminants from reaching groundwater through floor drains by adopting and enforcing a floordrain regulation. Such a regulation prohibits floor drains in areas that use or store hazardous materials, especially in water supply protection areas. A model floordrain regulation is available at http://www.mass.gov/dep/brp/dws/files/fdrmod.doc.

Work with Local Businesses

- ✓ Implement a program to educate businesses about hazardous material management requirements. For information on developing a hazardous materials management program, see http://www.mass.gov/dep/brp/dws/files/hazmat.doc.
- ✓ Develop and implement an Inspection Program for facilities that generate, use, store, or dispose of hazardous/toxic materials. Local Board of Health and Building Inspectors working on inspections often include floordrain and underground storage tanks. Local inspection programs can provide valuable technical assistance on Best Management Practices.

Municipal Planning

- ✓ Encourage local officials to become familiar with and implement a stormwater management program to meet DEP's Phase II Stormwater Regulations. For additional information, refer to the Stormwater Management Information at http://www.mass.gov/dep/brp/ww/wwpubs.htm#storm.
- ✓ Develop non-regulatory protection strategies that include Best Management Practices such as stenciling stormwater drains, hazardous waste collection days, recycling programs, regulatory controls, public education, and herbicide, pesticide and fertilizer management.

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How can I protect drinking water sources?

Water Suppliers Protect Drinking Water

Surface Water

Reservoir Source Protection

- ✓ Inspect the reservoir and Zone A areas frequently for wildlife impacts, especially from beaver and birds. Also check for illegal dumping and prohibited activities.
- ✓ Post signs around the Zone A to involve the community in protecting the areas closest to drinking water sources.
- ✓ Store water supply chemicals properly; ensure secondary containment is always used to capture any leaks or spills within the Zone A.
- ✓ Use propane or natural gas for backup power.
- ✓ Identify any floordrains in your protection areas and ensure their compliance with DEP Underground Injection Control regulations to prevent them from becoming a route for contamination to the groundwater.

Water Supply Planning

- ✓ Develop a Surface Water Supply Protection Plan. For more information, see http://www.mass.gov/dep/brp/dws/files/surfprot.doc for the guide "Developing a Local Surface Water Supply Protection Plan."
- ✓ Consider future water supply needs in your long-term and short-term planning. The sample Water Supply Business Plan is available on the web at http://www.mass.gov/dep/brp/dws/files/busplan.doc.
- ✓ Have an up-to-date Contingency Plan for providing adequate water in the event of temporary shortages.
- ✓ Have a current Emergency Response Plan. Assess the potential for releases at various points, develop communication protocols, specify spill response measures, and train water supply staff. An up-to-date emergency response handbook is available at http://www.mass.gov/dep/brp/dws/dwspubs.htm
- ✓ Develop a Land Acquisition Plan. Acquire land in your water supply protection areas, especially in the areas closest to your sources. Acquisitions can be accomplished by municipal and non-municipal water systems through conservation restrictions, land banking, land purchases and land donation. Sample conservation restrictions are available at: http://www.mass.gov/dep/brp/dws/.

Cooperation with Local Authorities

- ✓ Work with municipal planners to ensure they include you in the site plan review process for any new or expanded developments in the watershed. Take the opportunity to address water supply concerns at the initial stages of development.
- ✓ Work with the local Board of Health to target inspection of facilities within your watershed.

Education

- ✓ Provide information to residents, businesses, local officials and community groups on how they can help to protect local drinking water sources and their watersheds. Fact sheets are available at http://www.mass.gov/dep/brp/dws/.

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How can I protect drinking water sources?

DPWs Protect Drinking Water

Roads and Road Maintenance

- ✓ Contain and cover road salts and road-construction materials at municipal garages. Ensure that runoff is treated according to DEP regulations and directed away from drinking water sources. For more information, see also http://www.epa.gov/region1/steward/neeat/munis1.html
- ✓ If vehicles are washed at municipal garages and fire stations, all wash water should drain to a municipal sanitary sewer or tight tank.
- ✓ Handle hazardous materials and waste according to DEP regulations. For more information, see the "Requirements For Small Quantity Generators Of Hazardous Waste" at http://www.mass.gov/dep/bwp/dhm/files/sqgsum.pdf to determine your status and regulatory requirements.

Stormwater

- ✓ Develop and implement a stormwater management plan. For more information, see the Stormwater Handbook at http://www.mass.gov/dep/brp/ww/wwpubs.htm
- ✓ Use street sweeping and structural solutions such as swales and catchbasins to best manage stormwater from streets and parking lots. Route stormwater drains away from drinking water sources.
- ✓ Inspect and clean out stormwater catchbasins on a regular basis. Catchbasin cleanings are classified as solid waste and must be handled and disposed of in accordance with all DEP regulations, policies and guidance.

Household Hazardous Waste Disposal

- ✓ If your municipality does not already have household hazardous waste collection, help to set up collection, or work with neighboring communities to set up regional collections. See also http://www.mass.gov/dep/recycle/hproduct.htm.

Lawn Care and Landscaping

- ✓ Develop and follow a turf management program for athletic playing fields and municipal recreation areas that minimize fertilizer and pesticides, especially near water supplies. For more information on turf management, see: http://www.extension.umn.edu/distribution/horticulture/DG5726.html

Emergency Response

- ✓ Have copies of the local emergency response plans on hand, and be aware of the location of water supply protection areas in case the fire department and other municipal officials need your help in emergency response.

Municipal Buildings

- ✓ Implement standard operating procedures regarding proper storage, use and disposal of hazardous materials at public buildings. For more information, see also http://www.mass.gov/dep/bwp/dhm/dhmpubs.htm.

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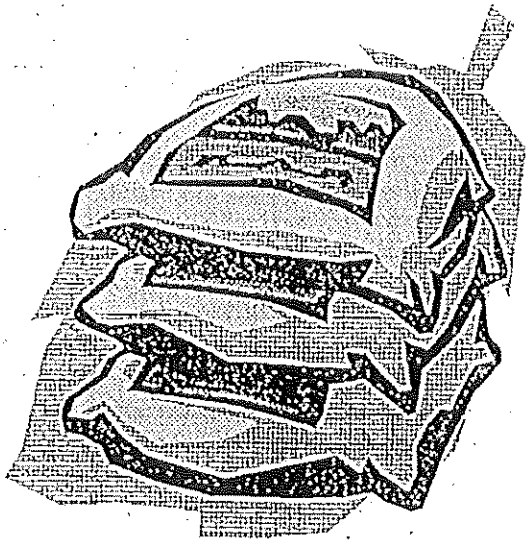
A MASSACHUSETTS BUREAU OF FARM PRODUCTS & PLANT INDUSTRIES FACT SHEET

Protecting Water Sources from Fertilizer

Fertilizers used to promote plant growth and lush green lawns also have the potential to contaminate water sources if applied improperly. The principle components of fertilizer are Nitrogen, Phosphorus and Potassium (N-P-K). Nitrogen is the main nutrient for new, green growth, Phosphorus promotes root development and Potassium improves the overall health of plants. Excessive amounts of nitrogen and phosphorus are the nutrients most likely to adversely affect water quality.



You can prevent ground and surface water contamination by observing the following practices when buying and applying fertilizers:

- Test your soil. Soil testing is the most critical step in any lawn fertility program by providing the information needed to select the fertilizer with the N-P-K value best suited to the nutritional needs of your soil. If you use a lawn care service insist they test your soil before any applications are made.

- Use a slow-release nitrogen fertilizer. There are two basic forms of nitrogen contained in fertilizer products: fast-release or Water Soluble Nitrogen (WSN), and slow-release or Water Insoluble Nitrogen (WIN). Slow-release fertilizers provide a more controlled release of nitrogen thereby limiting the amount of fertilizer leaching into groundwater. Also remember that weed and feed fertilizers contain pesticides which pose additional risks to water sources.

- Use iron as a supplement to nitrogen. Iron can be used alone or in combination with nitrogen to provide a greening response. Adding iron will decrease the amount of nitrogen needed thereby minimizing the amount of nitrate leaching into water sources.

- Choose the proper spreader and calibrate it correctly. By using a drop spreader instead of a rotary spreader near water supply sources and storm drains, you decrease the risk of fertilizer contamination. Proper calibration helps prevent misapplication of the fertilizer.

Time your fertilizer applications. Fast-acting fertilizers should not be applied before a heavy rainfall. Spring fertilization should be minimized—water tables are generally high at that time, thereby increasing the risk of fertilizer leaching into water sources. Do not apply fertilizer on frozen ground—the likelihood of runoff into water supply sources is dramatically increased. Avoid fall nitrogen applications on coarse-textured soils. These soil types have low water holding capacities and a high potential of nitrate leaching.

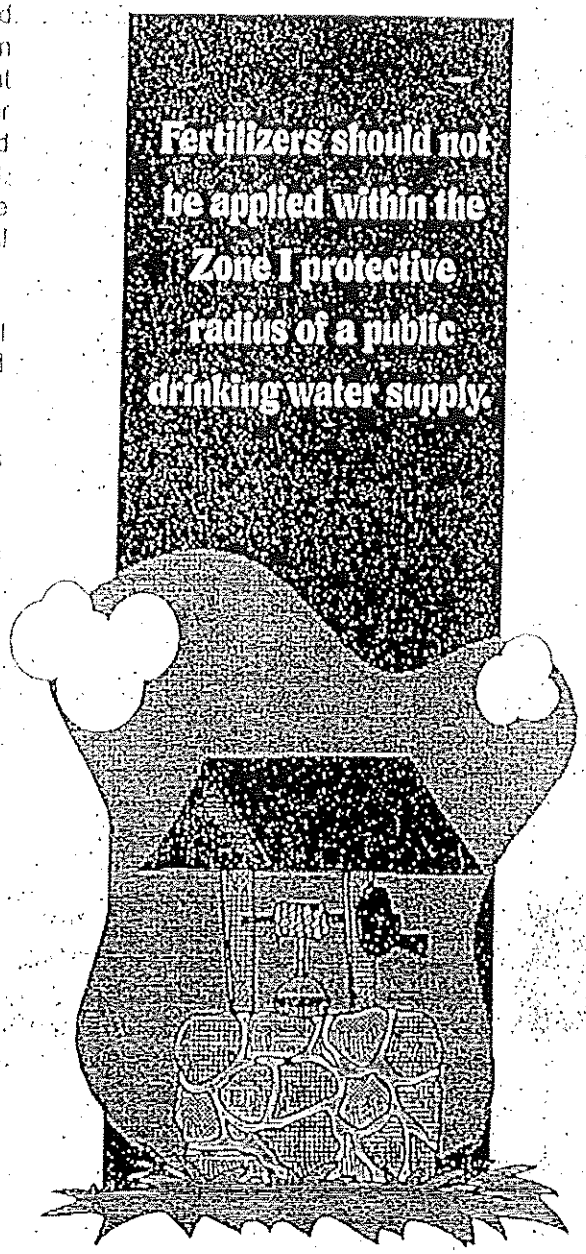
Use buffer strips. Leave a strip of unfertilized grasses or natural vegetation near any water body. This helps against erosion and produces a trap for unwanted nutrients.

Minimize fertilizer rates on slopes. The potential for runoff is decreased if you limit the amount of fertilizer in these locations.

Use a mulching mower. Mulching the grass and leaving the clippings reduces the need for fertilizer by as much as one-half.

Prevent misapplication of fertilizers. Take care when applying fertilizers around sewers and drains. Shut off spreaders before crossing sidewalks or driveways and sweep up any spills. Rinse your spreader over the lawn area and not on the driveway in order to minimize fertilizer runoff.

Properly store your fertilizer. Unused fertilizer should be removed from the spreader and returned to the original bag or container for future use. Store unused fertilizer in a dry place away from any water source. If stored fertilizer gets wet you not only lose nutrient value, there is potential for nitrates to leach into water sources.



Any questions or concerns about pesticide use should be directed to:

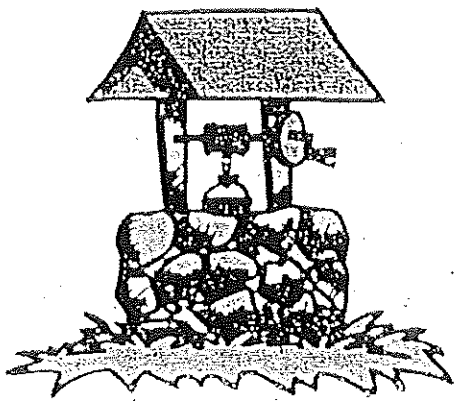
The Bureau of Farm Products and Plant Industries at the Massachusetts Department of Food and Agriculture (DFA), 251 Causeway Street, Boston, MA 02114. Telephone: 617- 626-1700. Website: www.massdfa.org

For information protecting water sources from Pesticide refer to the Pesticide Fact Sheet.

A MASSACHUSETTS PESTICIDE BUREAU FACT SHEET

Protecting Groundwater from Pesticides

Pesticides used to control weeds, insects and plant diseases have the potential to contaminate groundwater which is used as a drinking water source. Improper disposal, accidental spills, excessive or inappropriate use, misapplication, overuse and poor storage practices are all ways in which pesticides can contaminate groundwater supplies. Proper use of pesticides on your property is an important step toward preventing groundwater contamination.

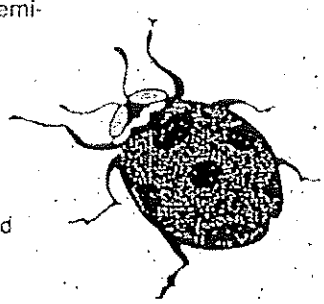


Pesticides are used almost everywhere and include:

- Herbicides such as weed killers, weed and feed products and cut stump treatments.
- Insecticides such as garden dusts and ant killers.
- Fungicides such as rose and flower sprays and anti-mildew paints.
- Rodenticides such as rat poison.
- Disinfectants such as swimming pool cleaners, bleach, ammonia, pool chemicals, toilet bowl cleaners, flea collars and flying insect sprays.

You can prevent contamination of groundwater by observing the following practices when you buy and apply pesticides:

Pesticides are not always necessary to control pests. Try non-chemical control methods. Remove pest habitats by cleaning up garbage and removing leaf piles, standing water and food scraps. Encourage beneficial insects such as spiders, ladybugs and lacewings which eat pests. Remove weeds by hand.

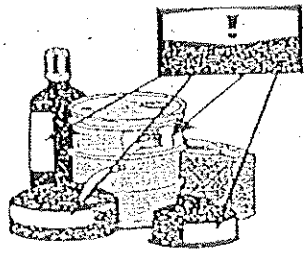


Learn to identify pests correctly so that you use the proper control techniques. Pests are listed on the label instructions. Do not confuse pests with insects which are beneficial such as the Big Eyed Bug, Ground Beetles and Ladybugs.

Before purchasing a pesticide learn as much as you can about the product and its potential hazards by reading the label. The label contains information concerning directions for use, application site and rate, storage and disposal, active ingredients, protective equipment needs and the types of pests controlled.

Buy only the amount of pesticides that you need for immediate use. The safest approach is to limit the amounts and types of pesticides stored. Keep products in their original containers with the label intact

Store pesticides out of the reach of children in a secured area such as a locked cabinet. Pesticides should not be stored over soil that is coarse or sandy or over surfaces that drain easily, such as gravel, because the pesticide can then easily move through the soil into the ground water. Storing pesticides in their original containers in a tray or tub offers an additional safeguard against leaks or spills.

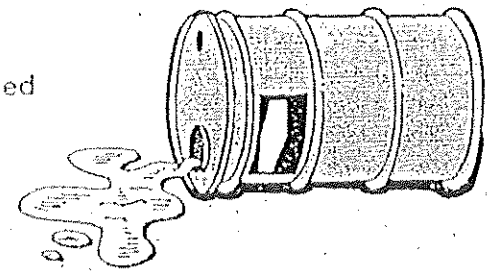


Apply pesticides according to label instructions. Apply the minimum amount of pesticide directly to the crop or pest rather than to the soil. Using more is not better. Use premixed pesticides or ready-to use pesticides, instead of ones you have to mix yourself.

Pesticides should not be applied within the Zone I protective radius of a public drinking water supply.

Apply chemicals based upon an understanding of the physical features of your property. Pesticides will drain to groundwater more easily in sandy soils than in clay soils. Pesticides should not be applied within the Zone I protective radius of a public drinking water supply. Most pesticides should not be applied if rain is forecast within 24 hours of application, unless label directions state otherwise.

If a spill occurs, the contaminated area should not be hosed down. This will cause the pesticide to spread and infiltrate into groundwater. Absorbent material such as vermiculite, clay, pet litter or activated charcoal should be on hand along with a garbage can and shovel to quickly contain and clean up any spills.



Dispose of pesticides properly. Take unused, unwanted and waste pesticides, pesticide containers and partially full aerosols to a local hazardous waste collection event. Do not dispose of them in the trash.

Any questions or concerns about pesticide use should be directed to:

The Pesticide Bureau at the Massachusetts Department of Food and Agriculture (DFA), 251 Causeway Street, Boston, MA 02114. Telephone: 617-626-1700. Website: www.massdfa.org

Pesticide Bureau publications include "An Environmentally Sound Approach to Lawncare", "IPM: A Kit for Building Managers" and "Guidelines for Storage, Mixing and Loading of Pesticides". All publications are available from DFA or are downloadable from the Pesticide Bureau website: www.massdfa.org/pesticide.htm

For information concerning drinking water protection, contact:

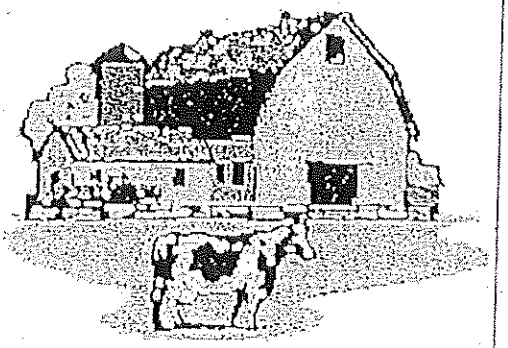
The Bureau of Resource Protection at the Department of Environmental Protection (DEP). Telephone: 617-292-5770. Website www.state.ma.us/dep

To dispose of unwanted pesticides:

Check for local household hazardous waste events with the Bureau of Waste Prevention at the Department of Environmental Protection (DEP). Telephone: 1-800-343-3420. For immediate assistance in the event of a pesticide poisoning incident, contact DEP at 1-800-682-9211.

Manure Management: Protecting Water Resources from Nutrient Pollution

Animal waste from barnyards, manure pits and field application can pollute ground and surface water when not contained or applied properly. By making Best Management Practices (BMPs) part of a conservation plan, a farmer can greatly reduce the chances of contamination. A manure system should prevent contamination of water in lakes, streams, springs and wells.



BMPs are managerial, such as manure management, rotational grazing, and conservation tillage, or structural, such as manure pits or lagoons, terraces and fencing.

You can prevent contamination of groundwater by observing the following practices:

MANAGERIAL

Apply manure appropriately - Determine the rate of application that will fulfill the crop's nutrient needs without causing environmental problems. This includes:

- Timing - Spread manure only when conditions are favorable. Avoid spreading manure in the winter or early spring, because manure applied to frozen ground can pollute surface waters during spring thaw run-off. If winter application is required, only spread manure on sod-covered fields where manure won't runoff as easily. *Do not spread manure in early spring, because the soil is often saturated.*
- Location - Avoid spreading manure on sloped lands or areas where manure could seep into water sources such as wetlands. Do not spread manure within 200 feet of a water source unless it can *immediately* be incorporated into the soil. *Avoid manure application on land subject to annual flooding, especially during flood prone periods.*
- Incorporation- Manure incorporated into soil is less prone to run-off than if it remains on the surface. Incorporate manure into the soil within 72 hours of application. *This is particularly important on slopes, near water bodies and during wet seasons.*

Test Soil and Manure

- Soil testing helps a farmer to decide what the nutrient needs are for the crop.
- Manure testing shows levels of nutrients in the manure.

By comparing the results of both tests, farmers can apply the right amount of manure. *Never apply more nutrients than needed – this is the first step in reducing nutrient run-off.*

Create a Composting site - By composting manure and other organic materials the farmer produces an excellent soil conditioner.

- Composting shrinks the weight and volume of manure and simplifies handling.
- Composting decreases odors and reduces the amount of pathogens.

Install and Maintain Buffer Areas. Riparian buffer zones are vegetated areas between streams or rivers and crop or pastureland. These forests and grasses act as living filters by absorbing nutrient and chemical run-off.

STRUCTURAL

Store manure properly - Manure should be stored in properly located and constructed facilities. The storage facility should be:

- Covered, contained, and impermeable to prevent runoff or leaching to the ground
- Have the capacity to hold a minimum of 3-6 months of manure.

Control Barnyard Run-off - Run-off from poorly managed barnyards and feedlots can carry pathogens, nutrients and oxygen-demanding substances into water sources.

- Shape barnyards by grading or filling so that run-off can be directed to a controlled outlet such as a *Settling Basin*
- *Grass Filter Strips* absorb nutrients from run-off reducing threats to surface waters

Install Fencing - For safety, livestock standing, feeding, and grazing areas are prohibited within 100 feet of drinking water reservoirs and their tributary streams. Construct barriers that prevent livestock or wildlife from accessing water sources. The farmer may need to bring water to livestock rather than livestock to water.

Construct Stream Crossings - Trampled stream banks erode easily allowing manure and sediments into surface waters. Limit the amount of access livestock have to stream banks by directing them over constructed stream crossings.

Build Diversions and Terraces - Divert run-off from critical areas using these channeled ridges or earthen embankments constructed perpendicular to slopes.

Install Grassed Waterways – Natural or constructed vegetated channels which filter and divert run off away from water resources.

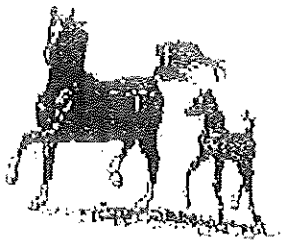
Use a Conservation Plan - Farm operators should have a conservation plan designed to optimize crop yield and minimize effects on ground and surface water. This plan could include many of the guidelines described in this fact sheet.

Any questions or concerns about manure use should be directed to:

The Farm Products and Plant Industries at the Massachusetts Department of Food and Agriculture (DFA), 251 Causeway Street, Boston, MA 02114. Telephone: 617-626-1700. Website: www.massdfa.org

For additional information on Best Management Practices, developing a conservation plan, or creating a composting site, call your local United States Department of Agriculture Conservation Service office or contact the Massachusetts Department of Food and Agriculture at 617-626-1700 or access their web site at www.massdfa.org. Funding for incorporating BMP's to a farm is available through both the USDA and MFDA.

PUBLIC EDUCATION MATERIALS: AGRICULTURAL MANAGEMENT



MANURE MANAGEMENT FOR HEALTHY HORSES

Proper manure management is an important consideration for everyone who owns horses. Containing, treating and disposing of horse manure routinely has many benefits, from maintaining friendly relations with our neighbors, protecting water quality, and helping to keep our horses healthy and happy. Manure-related nuisances, such as flies, and debilitating conditions such as thrush, scratches, parasite infestation, and abscesses can be prevented by employing some simple best management practices (BMPs) around your property. Integrating BMPs into your horse operation is a proactive way to protect the environment and your horse's health.

What are the health risks from manure?

- Horses allowed to graze in manure-laden fields are constantly at risk from parasite infestation.
- Manure piles in heavily trafficked areas, sheds, and shade areas provide breeding ground for flies and other insects. Insects at the very least harass your horse (and you), but also carry disease, bite, and can cause allergic reactions for you and your horse. The typical life cycle for stable flies is 21 to 25 days from egg to adult. During that time, a female can produce anywhere from 800 to 1,600 eggs!
- Horses forced to stand in manure and urine, either in soaked bedding in stalls, or paddocks and sheds, risk damaged and weakened hoofs, and are more susceptible to abscesses and thrush.
- Contaminants contained in manure, such as nutrients and pathogens (bacteria and viruses) can pollute your horse's drinking water supplies. Manure directly deposited in streams or lakes, or that runs off the surface of your pasture or paddock can end up in your horse's drinking water.
- Manure plus soil and water equals mud. Heavy organic-rich mud acts as a sponge, collecting and trapping water, creating a boggy mess in your paddock. Mud provides an excellent environment for bacteria and fungal organisms, which can cause thrush, abscesses, scratches and rain scald.

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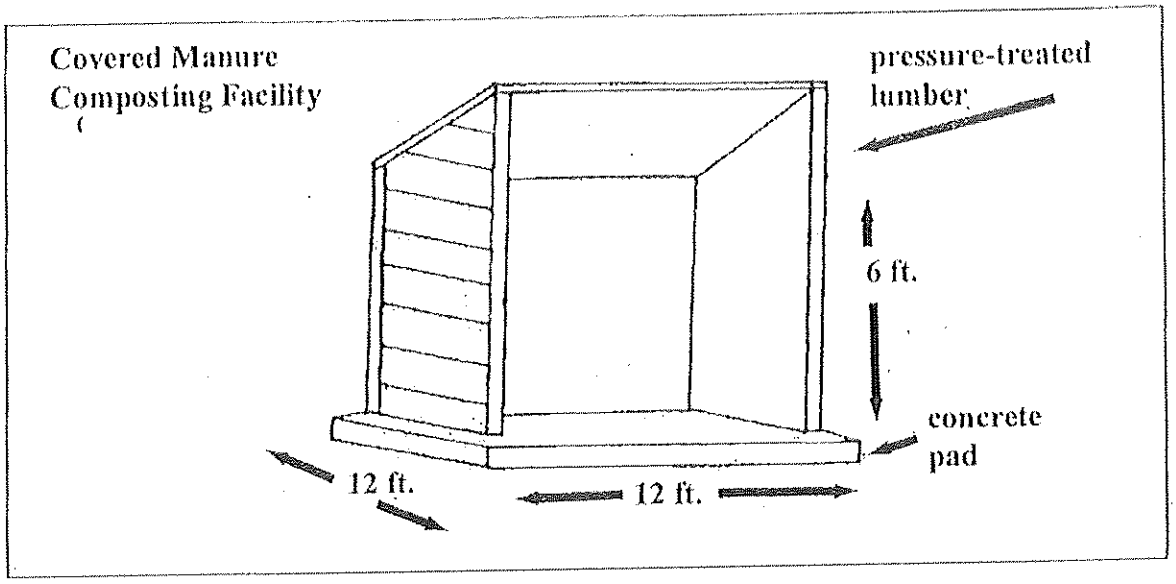
Produced by the Massachusetts Department of Environmental Protection, Municipal Services Section, Western Regional Office, 436 Dwight Street, Springfield, Massachusetts, 01103. 413-784-1100, TDD 413-746-6620. October 2000.

WHAT CAN I DO TO PROTECT MY HORSE?

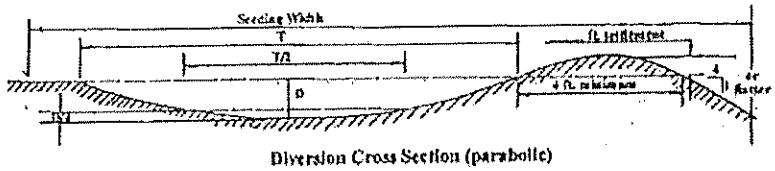
Routinely collect, treat, and dispose of manure from your pastures, paddocks, stalls, and shed areas to protect your horse from the harmful effects of manure. Collecting and composting manure is one way to deal with your horse's waste in a relatively inexpensive way. Maintaining an internal temperature of 135° to 160° will kill most pathogens, parasites, and weed seeds in your compost. Composted manure is a valuable fertilizer that can be applied to your pastures and gardens. Refer to the Composting fact sheet for more information.



Keep your pasture and paddock clean and dry by capturing and diverting runoff (rain water, snowmelt, and water from roofs and hoses) away from heavy traffic areas and manure storage areas.

Create a diversion ditch or swale: Diversions are generally constructed across a slope to intercept runoff and redirect or divert it away from sensitive resources or heavy use areas. Vegetation, such as grass, should be used to line the sides of the swale to prevent erosion and encourage pollutant removal.

Diversion

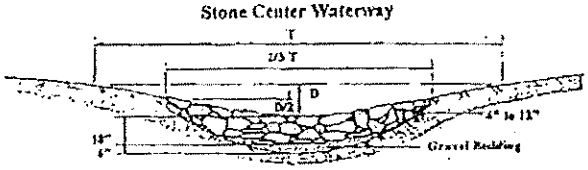


Diversion Cross Section (parabolic)

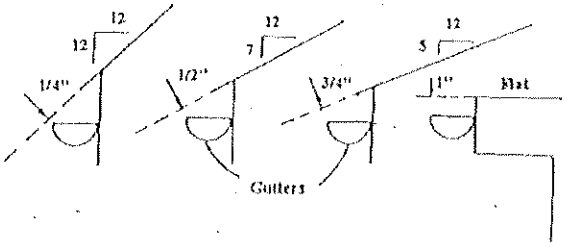
Grassed Waterway

Parabolic Shape Cross Section

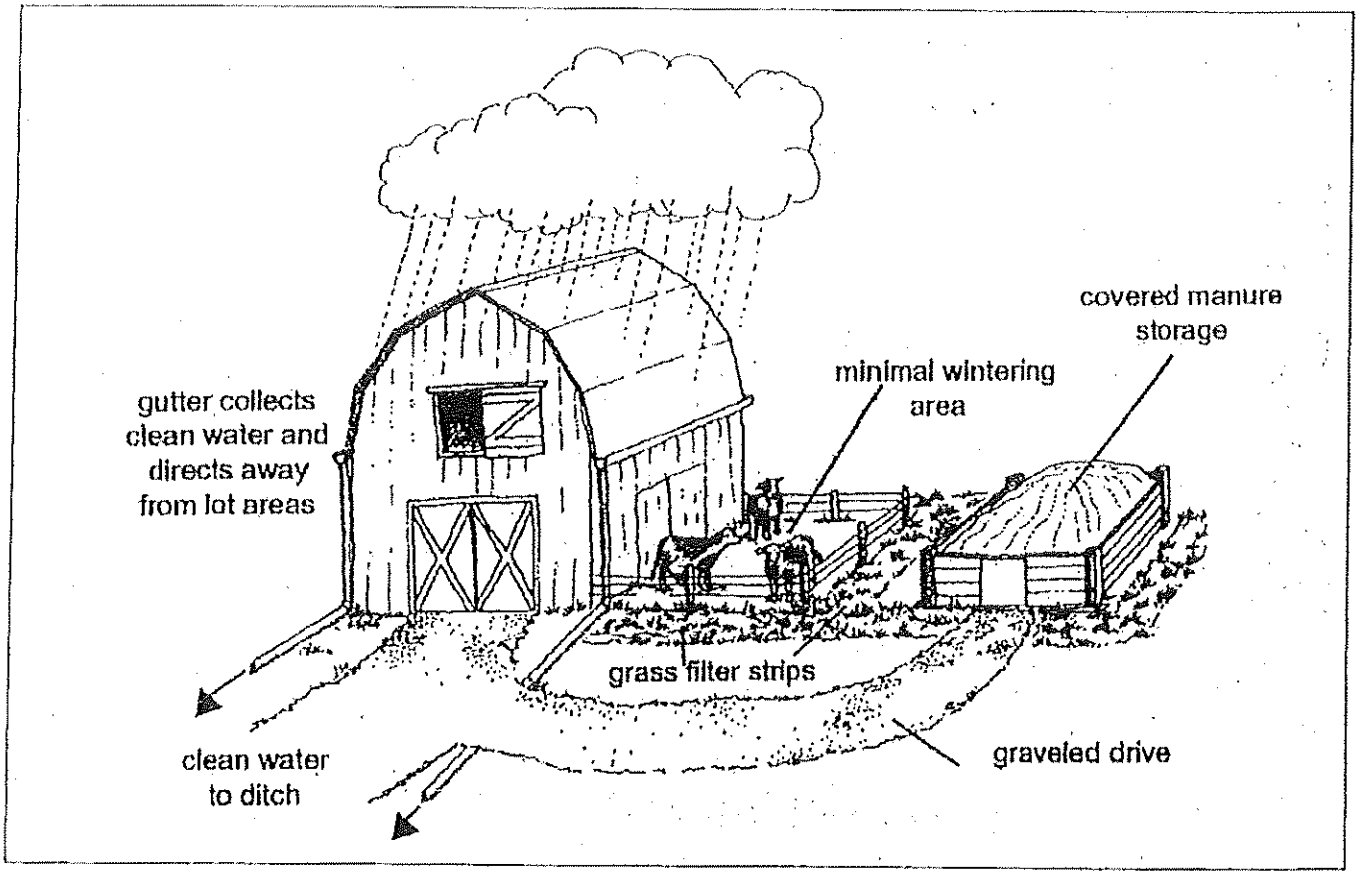
Stone Center Waterway



Capture roof runoff: Roof runoff can be directly diverted to a drywell for complete water infiltration, captured in a rain barrel, or diverted away from your shed or barn. Connecting downspouts to underground pipes which outlet away from loafing and high traffic areas is another option to deal with roof runoff.



Place gutters below the slope line so snow and ice can slide clear. A steeper pitch requires less clearance.



Additional Resources

http://neirtnt.ct.nrcs.usda.gov/horse

This web site contains information regarding manure management and information regarding specific best management practices (BMPs) such as water diversions, manure storage and vegetated buffers strips.

http://www.extension.umn.edu/distribution/naturalresources/DD7540.html
"Manure and Pasture Management for Recreational Horse Owners", a series of web sites by the University of Minnesota Extension Service. Includes plans for building a composting bin, detailed discussion of the composting process, information on pasture management, and an extensive list of additional sources of information.

http://members.aol.com/arblickle/tipsheets/
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http://ceinfo.unh.edu/aahr1050.pdf
This link takes you to the online version of the Good Neighbor Guide for Horse-Keeping: Manure Management, an excellent publication developed by the University of New Hampshire Cooperative Extension Service, New Hampshire Department of Environmental Services, and Natural Resources Conservation Service.

http://es.epa.gov/ncerqa_abstracts/centers/hsrc/biorem/bio11.html
A short summary of a project by the National Center for Environmental research, demonstrating the beneficial effect of riparian poplar tree buffers on water quality.

http://www.state.ma.us/dph/cdc/fwnvho.htm
"West Nile Virus: A Risk to Horses in Massachusetts?" West Nile Virus is a mosquito-borne disease, and mosquitoes need water for breeding. The mosquito that carries this virus breeds in stagnant water, not in ponds and wetlands. This fact sheet from the Massachusetts Department of Public Health discusses statistics, symptoms, ways to reduce risk, and provides links to other related sites.

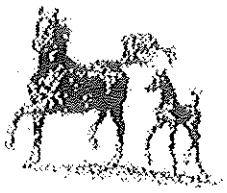
http://es.epa.gov/oeca/ag/sectors/animals/anbmp.html#Nutrient/Manure Management.htm
Agricultural best management practices (BMPs) from the US Environmental Protection Agency.

Massachusetts Department of Environmental Protection
Regional Nonpoint Source Coordinators (technical assistance and outreach)
Western Region - Tracey Miller 413-755-2162 or tracey.miller@state.ma.us
Central Region - Brian Duval 508-849-4027 or brian.duval@state.ma.us
Northeast Region - Rosalia Barber (Wollenhaupt) 978-661-7816 or rosalia.wollenahupt@state.ma.us
Southeast Region - Jeff Brownell 508-947-6557 or jeffrey.brownell@state.ma.us

Massachusetts Department of Food and Agriculture
http://www.massdfa.org/farmfunding/aeep/index.htm

Natural Resource Conservation Service Centers:

Berkshire CD	(413) 443-6867
Essex-Middlesex-Suffolk CD	(978) 692-1904
Bristol-Plymouth-Norfolk CD	(508) 295-5151
Hampden-Hampshire CD	(413) 586-5440
N.E.N.W., S. Worcester CD	(508) 829-6628
Cape Cod-Nantucket-Dukes CD	(508) 771-6476
Umass Coop Extension Service	(413) 545-4800



MANURE IMPACTS ON SURFACE WATER QUALITY

The quality of water directly impacts the quality of our lives. Contaminated water eliminates drinking water supplies for our horses and families, degrades our recreational water resources, and destroys wildlife habitat. Water that does not soak into the ground, whether from rain, snowmelt, a hose, or leaking pipes, is called runoff. Runoff picks up contaminants, such as nutrients, pathogens, and bacteria from manure and can transport them to the nearest water resource (lake, pond, wetland, stream, or river). Certain site conditions, such as steep and unprotected slopes, lack of vegetative cover, and proximity to receiving waters will encourage manure and contaminants associated with manure from entering surface water resources. Pollution carried by runoff is called nonpoint source pollution (NPS). Proper manure management and runoff management will protect or improve water quality on your property, and in your community and watershed.

Manure contains nutrients, such as phosphorous and nitrogen, and pathogens, including bacteria, viruses and parasites. These pollutants contaminate water resources and reduce recreational potential of lakes and rivers, destroy wildlife habitat, and eliminate drinking water supplies for people and livestock.

How does manure impact water resources?

When manure is deposited in water resources, either directly or by runoff, it can negatively impact water resources. The nutrients contained in manure, phosphorous and nitrogen, can be carried by runoff to the nearest water body, such as a pond, stream or lake. The nutrients then fertilize aquatic weeds and accelerate weed growth in lakes and ponds. The aquatic plants deplete oxygen levels, reducing the amount of oxygen available for other aquatic species such as fish. When the weeds die, additional oxygen is required for decomposition, further stressing oxygen stores and aquatic life. Direct manure entry into the water resource can also cause oxygen starvation due to increased biological oxygen demand (BOD), and result in fish kills. Algae blooms are another result of excess nutrients in the lake or pond. Algae blooms further reduce oxygen in the water body, can turn the water an unsightly murky green, and generate an unpleasant odor. Eutrophication (accelerated weed growth) and algae blooms kill fish and make swimming and boating unpleasant.

When the pathogens found in manure, including viruses, parasites, and bacteria such as fecal coliform and *e. coli*, are deposited into a stream or lake, swimming areas and shellfish beds may be closed. Pet and livestock drinking water supplies may be contaminated.

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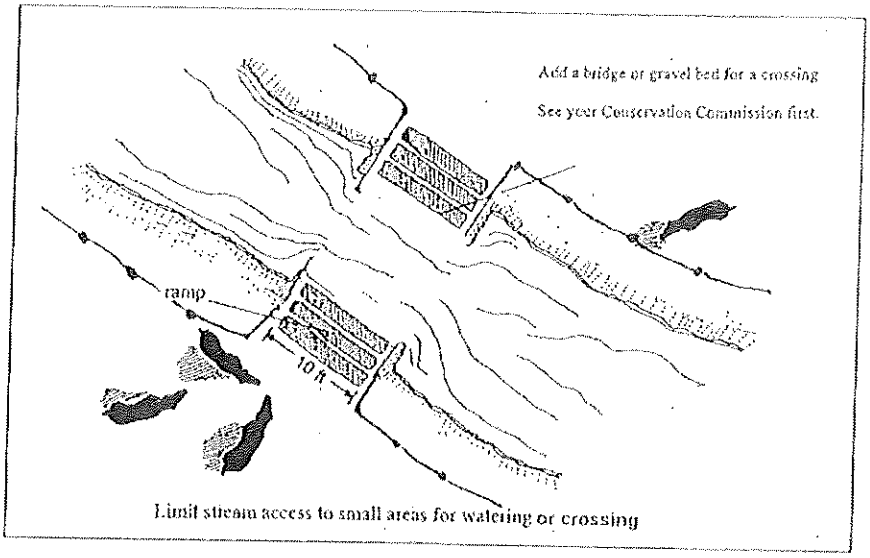
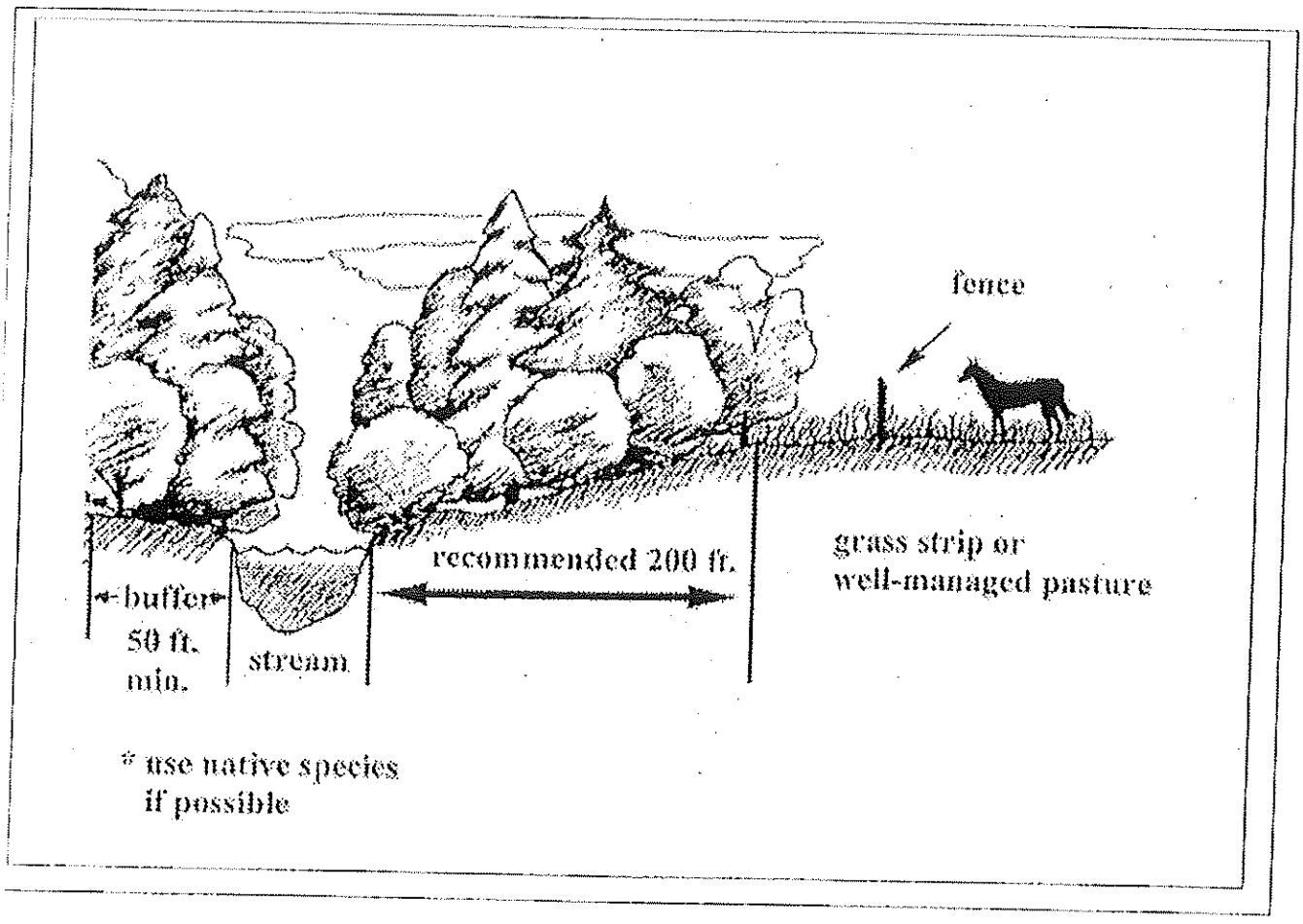
What Can I do To Protect Water Quality?

Prevent manure from being directly deposited in water resources. Keep horses out of streams, lakes, ponds and wetlands. If you can not completely fence your horse out of these areas, build water crossings to limit access as much as possible. (Note: Before installing anything in a waterbody you must contact your Conservation Commission.) Consider alternative water sources, such as troughs or an automatic watering system.



Establish a vegetated buffer strip between horses and any water resources. Don't be discouraged if you have a small area to work with. Any buffer strip is better than none at all!



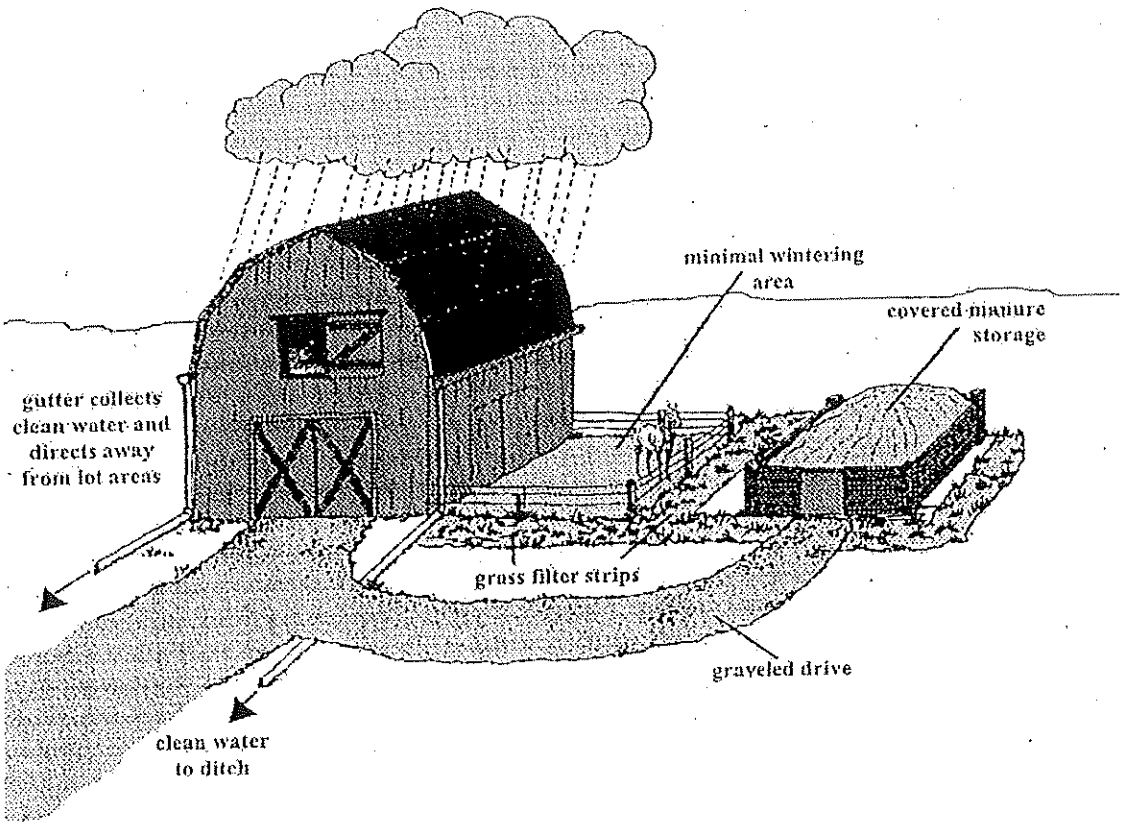
Manage your horse's manure. Proper manure management consists of containing manure, treating manure, and disposing of manure.

Contain: Pick up manure from stalls, paddocks and pastures on a daily or regular basis.

Treat: Composting manure is an effective way to transform waste into a valuable resource for your pastures and gardens. Maintaining a temperature of 135° to 160° will kill most pathogens, parasites and weed seeds. This means fewer flies on your property, reduced odors, and a reduced possibility of parasite infestation for your horse. Refer to the Composting fact sheet for more information.

Dispose: Composted manure is a valuable resource that can enhance the soil and fertilize your pastures and gardens. If you can rotate your pastures, composted manure can be spread in resting pastures during the growing season at no more than a ½ inch layer at a time. If manure is not composted, and you plan to spread it daily or routinely, spread manure on fields that will not be used for grazing, probably for at least a year. Composted manure can also be shared with horseless neighbors!

Minimize runoff. Encourage stormwater infiltration on your property to reduce runoff, and thus the transport of nutrients and pathogens to water resources. Small grassed depressions in your pasture can act as detention basins, capturing water, encouraging sediment and nutrients to filter out of the water, and encouraging infiltration. Roof gutters can direct rain and snowmelt to drywells or rain barrels. Divert storm runoff from high traffic areas and paddocks by constructing grassed swales or diversions.



Additional Resources:

http://neirtnt.ct.nrcs.usda.gov/horse

This link takes you to the Connecticut Horse Environmental Awareness Program (HEAP). The site contains a series of fact sheets, and educational resources on best management practices (BMPs).

http://members.aol.com/arblickle/tipsheets/index.html

This link takes you to Horses for Clean Water, a non-profit environmental education organization based in Washington state. The site has several fact sh 3 n a number of manure related topics including composting, eliminating mud, and pasture management. Contact Alayne Blickle, program coordinator, at 425-432-6116 or via email at ARBlickle@aol.com for more information.

http://www.extension.umn.edu/distribution/naturalresources/DD7540.html

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http://ceinfo.unh.edu/aahr1050.pdf

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http://www.netcnct.net/community/oacd/fs00safs.htm

A series of Small Acreage Fact Sheets by Oregon's Washington County Soil and Water Conservation District, including tips on controlling mud, providing alternative water sources for livestock, good and bad environmental practices, and a year-round calendar of activities for sound farm and pasture management.

Agency Resources

Massachusetts Department of Environmental Protection (MA DEP)

Regional Nonpoint Source Coordinators (technical assistance and outreach)

Western Region - Tracey Miller 413-755-2162 or tracey.miller@state.ma.us

Central Region - Brian Duval 508-849-4027 or brian.duval@state.ma.us

Northeast Region - Rosalia Barber (Wollenhaupt) 978-661-7816 or rosalia.wollenhaupt@state.ma.us

Southeast Region - Jeff Brownell 508-946-2702 or jeffrey.brownell@state.ma.us

Massachusetts Department of Food and Agriculture

http://www.massdfa.org/farmfunding/aeep/index.htm

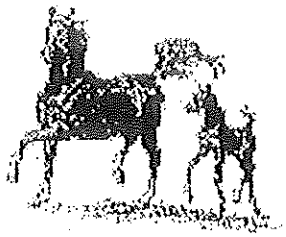
http://www.nrcs.usda.gov

The Natural Resources Conservation Service is a Federal agency that works in partnership with the American people to conserve and sustain our natural resources.

Natural Resource Conservation Service Centers:

Berkshire CD	413-443-6867	Hampden-Hampshire CD	413-586-5440
Essex-Middlesex-Suffork CD	978-692-1904	N.E.N.W., S. Worcester CD	508-829-6628
Bristol-Plymouth-Norfolk CD	508-295-5151	Cape Cod -Nantucket-Dukes CD	508-771-6476

UMass Cooperative Extension Service 413-545-4800



Mud and Pasture Management

Mud, like manure, is a problem that every horse owner must contend with. Mud is unhealthy, unsightly, annoying, and difficult to avoid or control. Mud can cause very serious environmental impacts when it is near surface waters or drinking water supplies. Rainfall and runoff can carry contaminants from the mud into your favorite swimming hole or trout creek, making the water unpleasant and unhealthy for people and animals. Horses, like people, need clean, fresh water to drink. Horses that drink from streams and farm ponds that are not properly managed to avoid mud and contaminated runoff will be forced to stand in mud while they drink dirty water.

Mud creates a very unhealthy environment for the horse.

Mud harbors bacteria and fungi, which cause diseases such as thrush, scratches, rain scald, rot, and abscesses. It creates slippery footing, which will result in added wear and tear on shoes and hooves and can cause injuries from slips and slides. Horses who are fed on muddy ground can ingest dirt and sand particles, causing a serious digestive disorder known as sand colic. Mud is a breeding ground for certain kinds of insects that will bite both you and your horse.

Mud is also inconvenient for horse owners. It makes chores difficult and unpleasant. Walking around in slippery mud makes it difficult to move from place to place, and treacherous when handling an unruly or energetic animal. Grooming becomes a nasty job when the horse is covered in mud.

What causes mud?

Some of the characteristics that make manure such a wonderful garden additive are also the reason why it contributes to spectacular mud. In order to make really good mud, we need a high organic content. If we start with a regular soil, or even pure sand; add plenty of organic material in the form of manure; pour on water from rainfall or downspouts; maybe add some hay for good measure; and mush it all together by stomping and chopping it with hard hooves, we'll have mud in no time. The organics from the manure will retain moisture for a long period of time, which is great for the garden but bad for making the mud go away.

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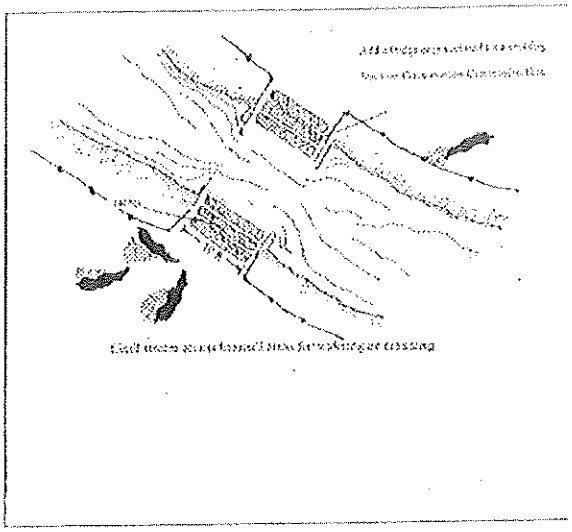
What can I do?



Here are a few tips to help you minimize or eliminate mud problems on your small farm.

Fence horses out of streams, ponds, and wetlands. If the animals must cross these areas to get to pasture, build water crossings to limit their access to the resources. (Contact your Conservation Commission to discuss permit requirements first.) Ideally, you can provide access to drinking water from a clean groundwater source, with a garden hose filling a stock tank or an automatic watering system. Put these watering spots in dry areas away from surface water, so that the traffic will not create new mud. You can find great hints about this at http://www.netcnct.net/community/oacd/fs09stoc.htm.

Practice good pasture management. Re-seed bare areas and keep horses off until healthy growth reappears. In the spring, restrict horses onto the higher, dry pasture ground until lower pastures have dried up. Confine your horses to a sacrifice area during the winter and spring to avoid hoof impacts on frozen or soggy pastureland. Avoid over grazing -- manage pasture for healthy plant growth, with roots that will help hold soil in place.

Regularly pick up manure and hay. If you can do nothing else, do this. This is also important for your horse's health, eliminating disease-causing bacteria and fungi, parasites, and insect breeding grounds.

Eliminating the source of organic material that would convert soil into mud is the single most important activity you can do.

Reduce rainwater impacts. Check out where your barn's roof runoff, drains and downspouts empty onto the ground. Where needed, construct or rearrange them to divert rainwater and runoff from dumping onto the ground in high traffic areas near barn doors and feeding areas. Once you have done this, keep the gutters and downspouts clean to ensure that they can function properly. If storm runoff spills into your paddock, construct swales or diversions to redirect the water where it can be absorbed somewhere else.

Add suitable footing. You can remove existing mud with a tractor or backhoe, and replenish the area with suitable footing such as sand or small gravel. In high traffic areas it may be necessary to do this every few years, but it is very effective and well worth the trouble. In addition, implementing the suggestions above will greatly extend the mud-free life of the new

footing. If you are planning to do this work near a wetland or surface water, be sure to check with your local conservation commission first.

By reducing the amount of mud on your farm, you will be creating a healthier, more secure home for your horses, a more attractive place for yourself and your family to live, and a cleaner, safer environment for everyone.

Additional resources:
http://members.aol.com/arblickle/tipsheets/

This link takes you to Horses for Clean Water, a non-profit environmental education organization based in Washington state. The site has several fact sheets on a number of manure related topics including composting, eliminating mud, and pasture management. A page called "Know Your Resources" lists many other useful web sites, programs and publications, including where to find pest control products, fly masks, bat houses, books, pamphlets, and newspaper bedding. Contact Alayne Blickle, program coordinator, at 425-432-6116 or via email at ARBlickle@aol.com for more information.

http://www.agf.gov.bc.ca/resmgmt/fppa/pubs/environ/horse/horse.htm

"Environmental Guidelines for Horse Owners", another series of web sites by the British Columbia Ministry of Agriculture and Food. Extensive coverage of environmental issues for horse owners including manure management and storage as well as more general resource protection issues. The site also provides other references.

http://www.extension.umn.edu/distribution/naturalresources/DD7540.html

"Manure and Pasture Management for Recreational Horse Owners", a series of web sites by the University of Minnesota Extension Service. Includes plans for building a composting bin, detailed discussion of the composting process, information on pasture management, and an extensive list of additional sources of information.

http://www.netcnct.net/community/oacd/fs11manu.htm

One of a series of Small Acreage Fact Sheets by Oregon's Washington County Soil and Water Conservation District, including tips on controlling mud, good and bad environmental practices, and a year-round calendar of activities for sound farm and pasture management.

http://www.netcnct.net/community/oacd/fs09stoc.htm

More from Oregon's Washington County Soil and Water Conservation District about how to provide water for stock without impacting streams and surface waters.

Agency Resources:

Natural Resource Conservation Service (NRCS) works with farmers on issues relating to the best use of our natural resources. This includes pasture, manure and mud management for horse owners. You can find the number for your NRCS office listed in the phone book under federal government, US Department of Agriculture, Natural Resource Conservation Service.

Conservation Districts also work with farmers and livestock owners, often for smaller, non-commercial places, on similar land management assistance. To find out about their services and get on their mailing list contact your local Conservation District by calling the NRCS office. The NRCS will be able to tell you the name, location and phone number of your Conservation District.

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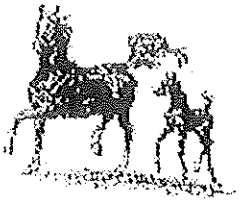
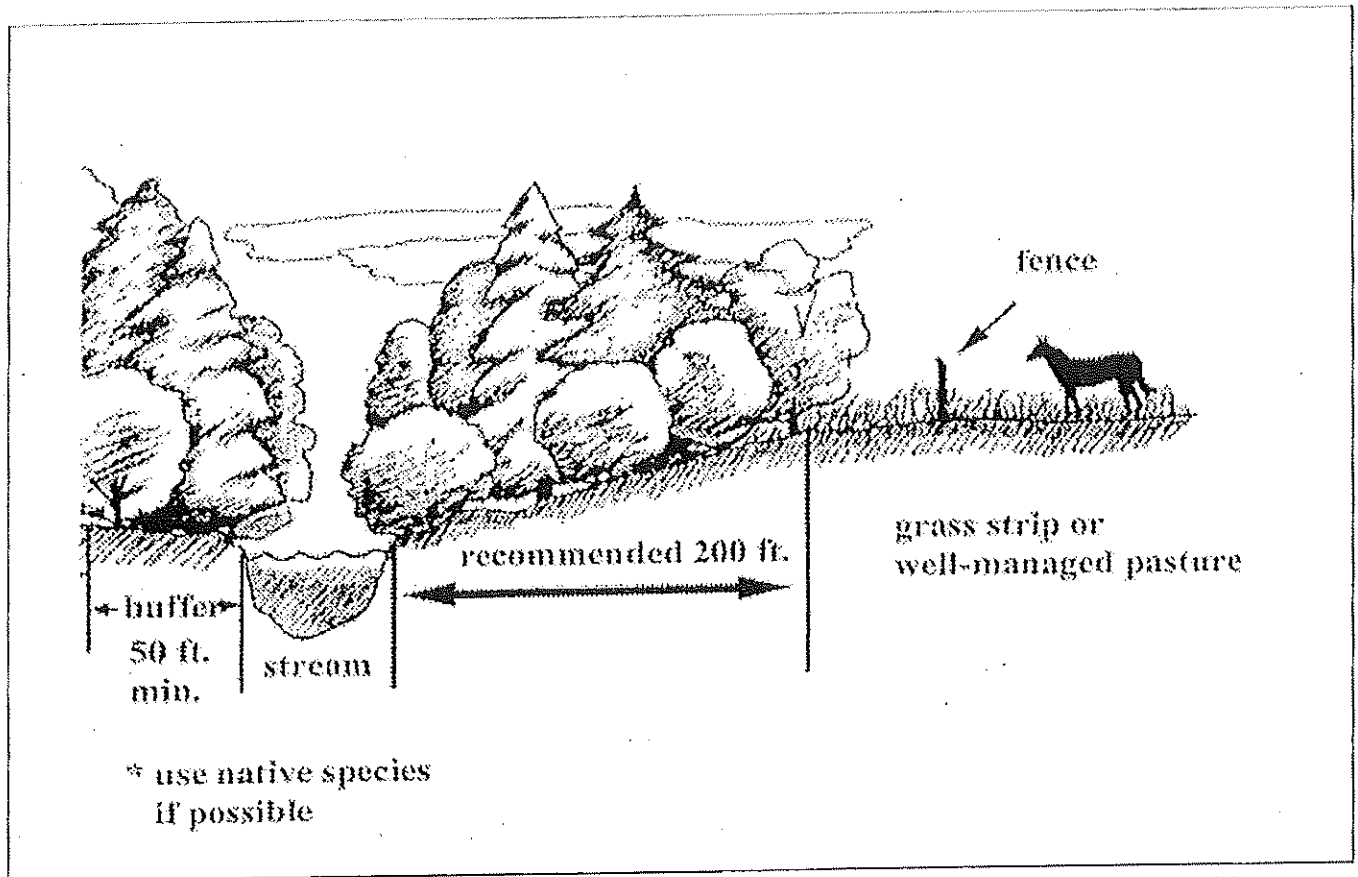
Central Region - Brian Duval 508-849-4027 or brian.duval@state.ma.us
Northeast Region - Rosalia Barber (Wollenhaupt) 978-661-7816 or rosalia.wollenahupt@state.ma.us
Southeast Region - Jeff Brownell 508-946-2702 or jeffrey.brownell@state.ma.us



VEGETATED BUFFER STRIPS: SLOW THE FLOW TO PROTECT WATER QUALITY

Establishing vegetated buffer strips along lakes and streams is a simple and inexpensive way to protect and improve water quality on your property and in your community. Buffer strips consist of planted or naturally occurring vegetation, such as shrubs, trees, and plants. The vegetation serves as a filter, straining out sediments, nutrients, pesticides and other pollutants before they reach the water body. Buffer strips stabilize streambanks and shorelines, and prevent bank erosion and slumping. Runoff slows down and loses much of its erosional force when it passes through the strip of vegetation. Trees and shrubs along streams and lakes provide shade to keep water cool, improving habitat for aquatic organisms, and provide cover and habitat for wildlife. The wider the buffer strip, the greater its effectiveness. Strips between 50 and 200 feet wide may be required, based on soil type, size and slope of the pasture, and vegetative cover. A good rule of thumb is at least 50 feet wide, while keeping as much distance as possible between fencing and surface water.



Note: MA DEP regulations prohibit hitching or keeping animals within 100 feet of the bank of any public water supply reservoir, brooks, or streams tributary to a reservoir.

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Don't be discouraged if you have very small areas to work with. Any buffer strip is better than none at all!

Establishing a Buffer Strip

Buffer strips consist of planted or naturally occurring vegetation, such as trees, shrubs, legumes, or grasses. Establishing a natural buffer is the simplest and least expensive option. Simply determine how much land area you can devote to the buffer, and commit to stop mowing or removing vegetation from the area. With a little patience, plant material will naturally become established and grow. Plants establish themselves in succession, and it will probably take several years for trees and woody shrubs to develop in your buffer strip. The advantage of a natural buffer strip is that the native plants that do become established are adapted to local conditions, require no maintenance, and are a natural part of the ecosystem.

If the vegetation has been removed, or you wish to accelerate the development of your buffer strip, plant horse-friendly native trees and shrubs. Check with your local cooperative extension service, veterinarian, or consult a field guide of toxic plants to determine what is safe for your horses. If you can not restrict horses from the buffer strip, you may need to fence off saplings to prevent horses from nibbling tender leaves and shoots. While the trees and shrubs are being established, plant grasses and legumes to hold and stabilize the soil.

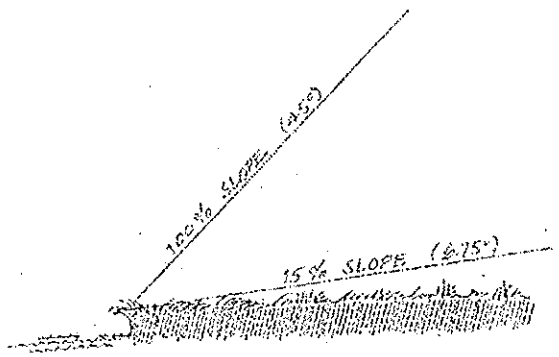
Regardless of what type of buffer strip you decide to encourage on your property, remember to:

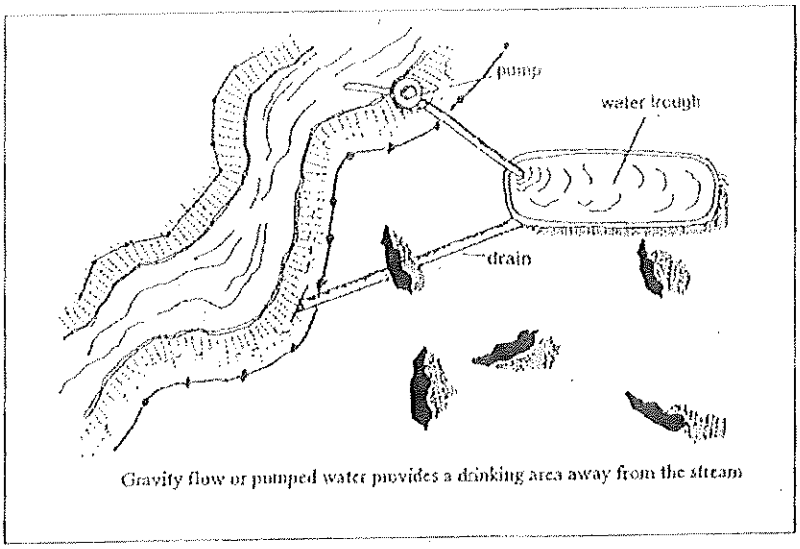
- Keep as much distance as possible between your field boundary and surface water.

Recommended Buffer Strip Widths Based on Slope

Slope of Land (%)	Minimum width of Buffer Strip (feet)
0	50
5	70
10	90
15	110
20	130
25	150

Source: Finley 1987 in *Establishing Vegetative Buffer Strips Along Streams to Improve Water Quality*. Pennsylvania State University. 1996.

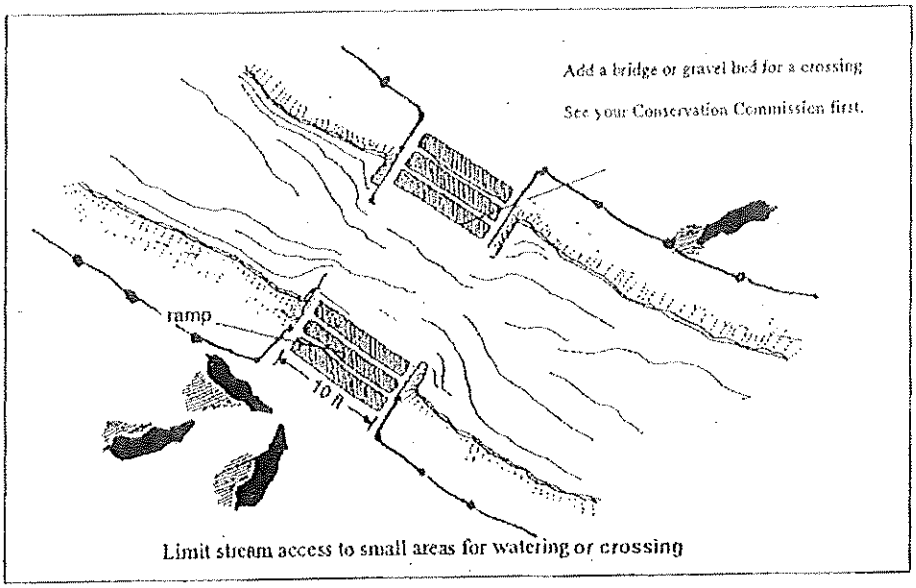




Gravity flow or pumped water provides a drinking area away from the stream

- If at all possible, restrict access to streams and lakeshores. Provide alternative water sources, such as filling a stock tank with a garden hose or installing an automatic waterer, to keep horses out of the stream.

- If horses must rely on stream or lake water for drinking, limit their access with fencing and construct a ramp fence system. Note: Contact your Conservation Commission first.



Limit stream access to small areas for watering or crossing

What else can you do to protect and improve water quality?

- Minimize hard or impervious surfaces on your property, and maximize pervious surfaces to encourage infiltration and reduce runoff.
- Maintain vegetation, preferably trees and shrubs, along steep slopes, drainage channels or ditches, and around all bodies of water.
- Do not apply manure in the buffer strip! Maintain a distance of at least 100 feet between areas of manure application and the nearest surface water body.
- Establish other grassed or vegetated strips between fields. These vegetated strips will intercept pollution, slow down the flow and velocity of runoff, and encourage infiltration.

References and Other sources of Information:

The Buffer Handbook: "A Guide to Creating Vegetated Buffers for Lakefront Properties." Developed by Phoebe Hardesty, Androscoggin Valley Soil and Water Conservation District and Cynthia Kuhns, Lake and Watershed Resource Management Associates, with funding provided by the U.S. EPA and Maine DEP. 1998

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http://www.wisc.edu/farmasyst/worklink.html
Links to Farm and Home assistance addressing farm management and environmental management for homeowners.

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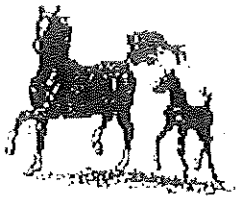


VEGETATED BUFFER STRIPS: SLOW THE FLOW TO PROTECT WATER QUALITY

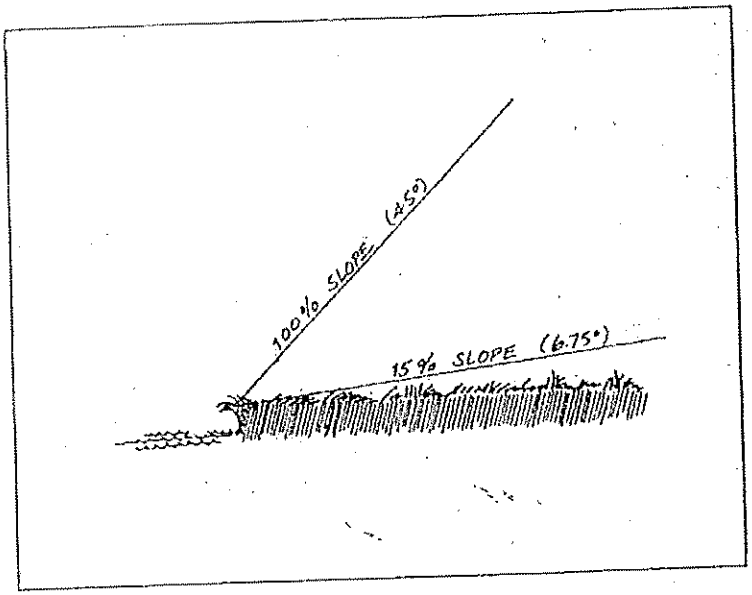
Establishing vegetated buffer strips along lakes and streams is a simple and inexpensive way to protect and improve water quality on your property and in your community. Buffer strips consist of planted or naturally occurring vegetation, such as shrubs, trees, and plants. The vegetation serves as a filter, straining out sediments, nutrients, pesticides and other pollutants before they reach the water body. Buffer strips stabilize streambanks and shorelines and prevent bank erosion and slumping. Runoff slows down and loses much of its erosional force when it passes through the strip of vegetation. Trees and shrubs along streams and lakes provide shade to keep water cool, improving habitat for aquatic organisms, and provide cover and habitat for wildlife. The wider the buffer strip, the greater its effectiveness. Strips between 50 and 200 feet wide may be required, based on soil type, size and slope of the pasture, and vegetative cover. A good rule of thumb is at least 50 feet wide, while keeping as much distance as possible between fencing and surface water.

Note: MA DEP regulations prohibit hitching or keeping animals within 100 feet of the bank of any public water supply reservoir, brooks or streams tributary to a reservoir.

Recommended Buffer Strip Widths Based on Slope

Slope of Land (%)	Minimum width of Buffer Strip (feet)
0	50
5	70
10	90
15	110
20	130
25	150

Source: Finley 1987 in *Establishing Vegetative Buffer Strips Along Streams to Improve Water Quality.* Pennsylvania State University. 1996.



This information is available in alternative format by calling our ADA Coordinator at (617) 574-6872.
Produced by the Massachusetts Department of Environmental Protection, Municipal Services Section, Western Regional Office, 436 Dwight Street, Springfield, Massachusetts, 01103. 413-784-1100, TDD 413-746-6620. October 2000.

Don't be discouraged if you have very small areas to work with. Any buffer strip is better than none at all!

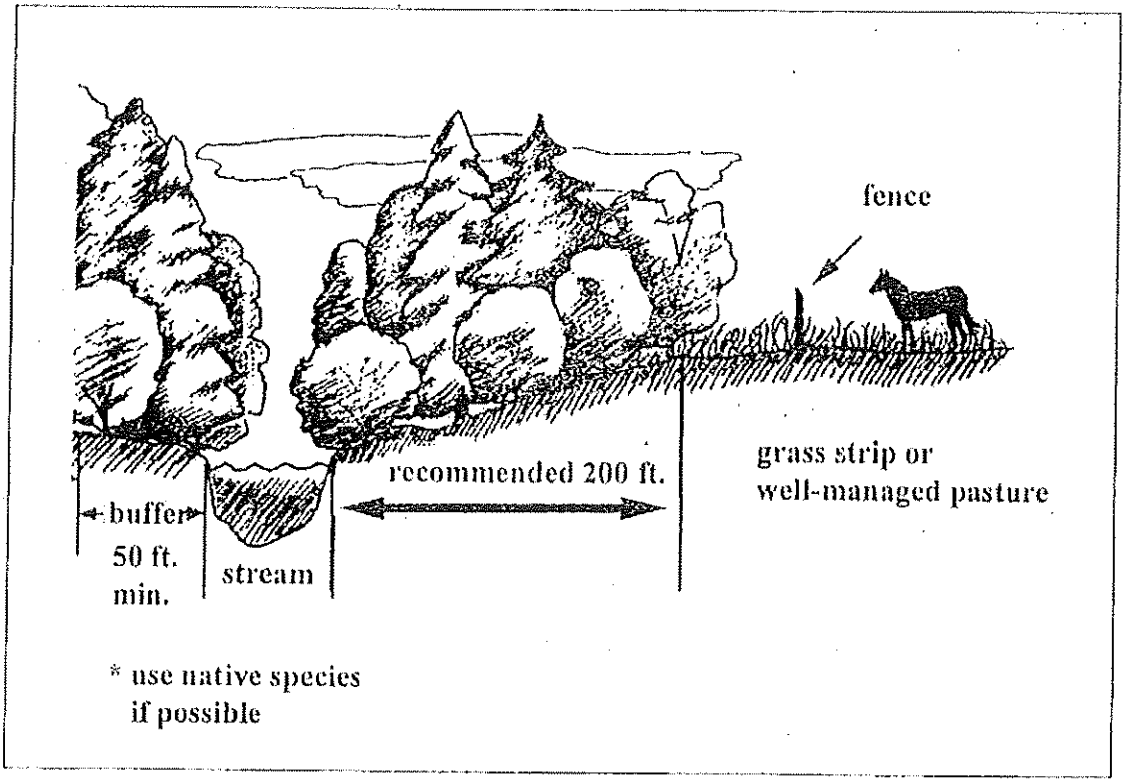
Establishing a Buffer Strip

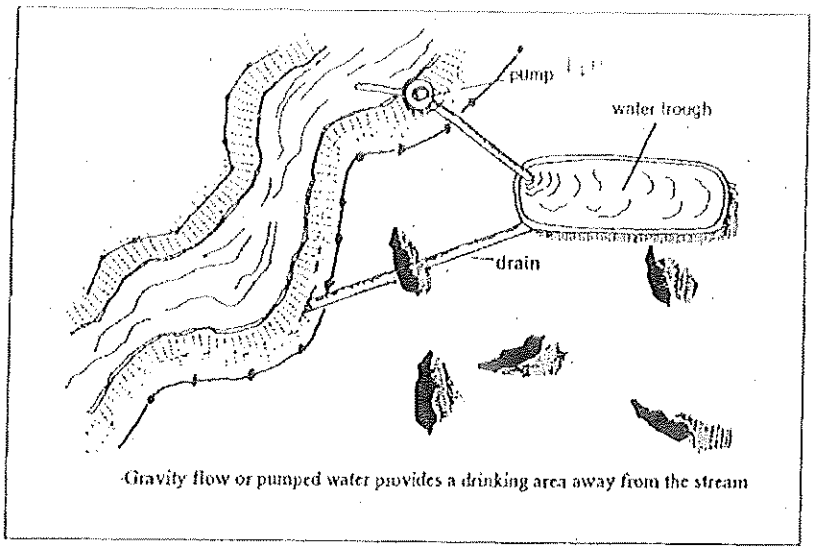
Buffer strips consist of planted or naturally occurring vegetation, such as trees, shrubs, legumes, or grasses. Establishing a natural buffer is the simplest and least expensive option. Simply determine how much land area you can devote to the buffer, and commit to stop mowing or removing vegetation from the area. With a little patience, plant material will naturally become established and grow. Plants establish themselves in succession, and it will probably take several years for trees and woody shrubs to develop in your buffer strip. The advantage of a natural buffer strip is that the native plants that do become established are adapted to local conditions, require no maintenance, and are a natural part of the ecosystem.

If the vegetation has been removed, or you wish to accelerate the development of your buffer strip, plant horse-friendly native trees and shrubs. Check with your local cooperative extension service, veterinarian, or consult a field guide of toxic plants to determine what is safe for your horse. If you can not restrict your horses from all of your buffer strip, you may need to fence off saplings to prevent your horse from nibbling tender leaves and shoots. While the trees and shrubs are being established, plant grasses and legumes to hold and stabilize the soil.

Regardless of what type of buffer strip you decide to encourage on your property, remember to:

- Keep as much distance as possible between your field boundary and surface water.





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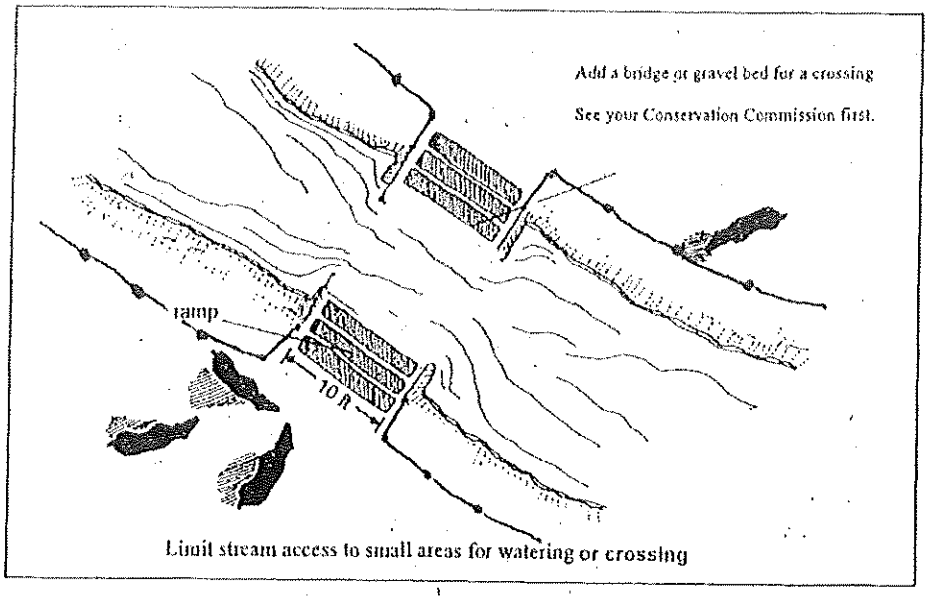

Limit stream access to small areas for watering or crossing

What else can you do to protect and improve water quality?

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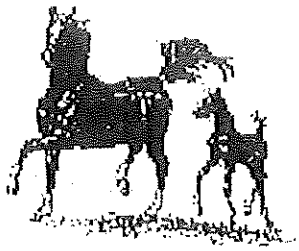

Composting

If you have horses, you've got manure. Chances are that you already spend some time each day cleaning stalls and picking up manure in your pasture, paddock, and riding ring. You could simply stockpile the manure and discarded bedding, and use it for your garden; but fresh manure is not really ideal for that. You could spread it on your fields, but you don't have a tractor. The pile just gets bigger.... The neighbors start to complain about flies and odor, and the growing pile slowly begins to obstruct your view of the beautiful horses in your back yard. Friends and family refuse to take any away to put on their gardens, because it's yucky and full of weeds. Still the pile grows...what's a poor horse owner to do?

With a little extra effort, you can compost your manure and create a valuable, useful, "black gold" that will make your gardens beautiful and your property more pleasing. Envious neighbors will soon be competing with your friends and family for a wheelbarrow full of the beautiful, fluffy stuff.

One average sized horse produces about fifty pounds of manure daily, about 8 tons per year!

What's so special about compost?

Composting your manure has many benefits:

- Compost is a wonderful soil amendment, rich in nutrients and organic material
- The heat generated in the composting process kills worm eggs and parasites, reducing the likelihood of parasite infestation in your horses
- The heat also kills weed seeds, enhancing its value as a soil amendment
- Flies will be reduced because their breeding grounds will be eliminated
- The volume of material you begin with will be reduced by about fifty percent
- Properly prepared compost is virtually odorless
- It reduces the chances that manure-contaminated runoff from your property will reach ponds and wetlands near your property
- It reduces the chances of contaminating groundwater and private wells in the area

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What is composting, anyway?

Composting is the process of managed, accelerated decomposition.

During the composting process, microorganisms break the organic materials into smaller particles and build new molecules. In doing so, they give off carbon dioxide, water vapor, and heat. Composting accelerates decomposition by promoting the growth of microorganisms. The heat that is generated kills weed seeds and reduces pathogens, worm eggs and parasites. Odors are virtually eliminated from the final product, which will be approximately half the volume of the material you started with. The finished compost is a valuable soil amendment, adding nutrients, organic material, and texture to the soil.

Composting is a balancing act. Providing ideal environmental conditions for microbial growth accelerates the process. Just enough water, air, carbon, and nitrogen getting piled, turned, and aged without contaminants makes for good compost.

How do I get started?

You can get started with composting just by building piles of manure combined with bedding, leaves, grass clippings, and other materials. Microorganisms love company, though, and your pile will need to be at least one cubic yard in size for the process to really work. It can be much larger. Ideally, you'll build one or more bins that will allow you to build and manage your composting process. You can find several sets of plans for building simple, inexpensive composting bins in the sources listed at the end of this fact sheet.

To avoid creating pollution at the composting site, make certain your compost pile is located a minimum of 50 feet from ponds and streams, and 100 feet away from drinking water wells. Make certain to contain any runoff on-site. If possible, a roof over the compost pile will prevent rainfall from washing away nutrients and help you to control the moisture levels in the pile, while avoiding contaminated runoff leaving the site.

Horse manure and bedding contain the carbon and nitrogen necessary for successful composting. Oxygen is also essential. The pile must have sufficient air spaces for the microorganisms to breathe while they work, and allow the resulting carbon dioxide to exit. Water is another requirement, ideally at a moisture content of around fifty percent. If the compost feels like a freshly wrung out sponge, the moisture level is perfect.

The challenge is to ensure the proper proportions of the materials. The type of bedding you use and the typical daily volume you discard will substantially affect the ease and rate of composting. Different types of organic materials compost differently. You'll need to

customize the process to fit your specific combination of manure, bedding, and other organic materials. You can find the best mixture by developing a clear understanding of the process, accurately measuring materials, and going through some trial and error. A working compost pile should be turned occasionally. This will help maintain air spaces in the pile, distribute moisture, and keep the microorganisms working. Since the pile will generate heat as it works, you'll know it's time to turn the pile when it starts cooling down.

Nutrient and soil conditioning value of compost

Depending on the size of the piles and the diligence with which you manage them, you could have finished compost in three to six months. You'll know it's finished when it no longer reheats after turning, the volume is reduced to one-half, and the product looks more like soil than anything else.

The major fertilizer components of manure and compost are nitrogen, phosphorus and potassium; many other trace elements are also present. In general, livestock manure compost contains about 0.5% nitrogen, 0.4% phosphorus, and 0.2% potassium. In addition to the nutrients it provides, applying compost to the soil can improve its physical structure by adding organic material that improves aeration, moisture retention, and permeability.

For effective composting, you'll need the right combination of nitrogen (manure and/or grass clippings), carbon (shavings, wood chips, leaves), air, and water.

Additional information and resources:

Web sites

http://www.extension.umn.edu/distribution/naturalresources/DD7540.html

"Manure and Pasture Management for Recreational Horse Owners", a series of web sites by the University of Minnesota Extension Service. Includes plans for building a composting bin, detailed discussion of the composting process, information on pasture management, and an extensive list of additional sources of information.

http://www.agf.gov.bc.ca/resmgmt/fppa/pubs/environ/horse/horse.htm

"Environmental Guidelines for Horse Owners", another series of web sites by the British Columbia Ministry of Agriculture and Food. Extensive coverage of environmental issues for horse owners including manure management and storage as well as more general resource protection issues. The site also provides other references.

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Agency Resources

Natural Resource Conservation Service (NRCS) works with farmers on issues relating to the best use of our natural resources. This includes pasture, manure and mud management for horse owners. Find them in the phone book under federal government, US Department of Agriculture, Natural Resource Conservation Service.

Conservation Districts also work with farmers and livestock owners, often for smaller, non-commercial places, on similar land management assistance. To find out about their services and get on their mailing list, contact your local Conservation District by calling the NRCS office. The NRCS will be able to tell you the name, location and phone number of your Conservation District.

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United States Environmental Protection Agency | Office of Water (4503F) | EPA-841-F-96-004F March 1996

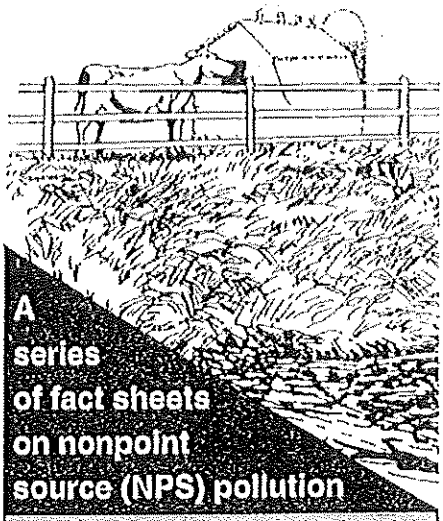
EPA

Nonpoint Pointers

Understanding and managing nonpoint source pollution in your community

Pointer No. 6

Managing Nonpoint Source Pollution from Agriculture



A series of fact sheets on nonpoint source (NPS) pollution

The United States has more than 330 million acres of agricultural land that produce an abundant supply of low-cost, nutritious food, feed, and fibre. American agriculture is noted worldwide for its high productivity, quality, and efficiency in delivering goods to the consumer. However, when improperly managed, agricultural activities can affect water quality.

The most recent *National Water Quality Inventory* reports that agricultural nonpoint source (NPS) pollution is the leading source of water quality impacts to surveyed rivers and lakes, the third largest source of impairments to surveyed estuaries, and also a major contributor to ground water contamination and wetlands degradation.

Agricultural activities that cause NPS pollution can result from confined animal facilities, grazing, plowing, pesticide spraying, irrigation, fertilizing, planting, and harvesting.

Agricultural activities that cause NPS pollution include confined animal facilities, grazing, plowing, pesticide spraying, irrigation, fertilizing, planting, and harvesting. The major agricultural NPS pollutants that result from these activities are sediment, nutrients, pathogens, pesticides, and salts. Agricultural activities also can damage habitat and stream channels. Impacts on surface water and ground water can be minimized by properly managing activities that can cause NPS pollution.

Numerous government programs are available to help people design and pay for management approaches to prevent and control NPS pollution. For example, over 40 percent of section 319 Clean Water Act grants were used to control agricultural NPS pollution. Also, several U.S. Department of Agriculture and state-funded programs provide cost-share, technical assistance, and economic incentives to implement NPS pollution management practices. Many people use their own resources to adopt technologies and practices to limit water quality impacts.

Managing Sedimentation. Sedimentation occurs when wind or water runoff carries soil particles from an area, such as a farm field, and transports them to a water body, such as a stream or lake. Excessive sedimentation clouds the water, which reduces the amount of sunlight reaching aquatic

Did you know that NPS pollution from agriculture is the leading source of impairments to surveyed rivers and lakes?

NPS pollution occurs when water runs over land or through the ground, picks up pollutants, and deposits them in surface waters or introduces them into ground water.

plants; covers fish spawning areas and food supplies; and clogs the gills of fish. In addition, other pollutants like phosphorus, pathogens, and heavy metals are often attached to the soil particles and wind up in the water bodies with the sediment. Farmers and ranchers can reduce erosion and sedimentation 20 to 90 percent by applying management measures to control the volume and flow rate of runoff water, keep the soil in place, and reduce soil transport.

Managing Nutrients. Nutrients such as phosphorus, nitrogen, and potassium in the form of fertilizers, manure, sludge, irrigation water, legumes, and crop residues are applied to enhance production. When they are applied in excess of plant needs, nutrients can wash into aquatic ecosystems where they can cause excessive plant growth, which reduces swimming and boating opportunities, creates a foul taste and odor in drinking water, and kills fish. In drinking water, high concentrations of nitrate can cause methemoglobinemia, a potentially fatal disease in infants also known as "blue baby syndrome." Nutrient management plans can help maintain high yields and save money on the use of fertilizers while reducing NPS pollution.

Managing Confined Animal Facilities. By confining animals to areas or lots, farmers and ranchers can efficiently feed and maintain livestock. But these confined areas become major sources of animal waste. Runoff from poorly managed facilities can carry pathogens (bacteria and viruses), nutrients, and oxygen-demanding substances that contaminate shellfishing beds and other major water quality problems. Ground water can also be contaminated by seepage. Discharges can be limited by storing and managing facility wastewater and runoff with an appropriate waste management system.

Managing Irrigation. Inefficient irrigation can cause water quality problems. In arid areas, for example, where rainwater does not carry residues deep into the soil, excessive irrigation can concentrate pesticides, nutrients, disease-carrying microorganisms, and salts-all of which impact water quality-in the top layer of soil. Farmers can control these effects by improving water use efficiency. Actual crop needs can be measured with a variety of equipment.

Managing Pesticides. Pesticides, herbicides, and fungicides are used to kill pests and control the growth of weeds and fungi. These chemicals can enter and contaminate water through direct application, runoff and wind transport. They can kill fish and wildlife, poison food sources, and destroy animal habitat. Integrated Pest Management (IPM) techniques based on the specific soils, climate, pest history, and crop for a particular field can limit pesticide use and manage necessary applications to minimize pesticide movement from the field.

Managing Livestock Grazing. Overgrazing exposes soils, increases erosion, encourages invasion by undesirable plants, destroys fish habitat, and reduces the filtration of sediment necessary for building streambanks, wet meadows, and floodplains. To reduce the impacts of grazing on water quality, farmers and ranchers can adjust grazing intensity, keep livestock out of sensitive areas, provide alternative sources of water and shade, and revegetate rangeland and pastureland.

RELATED PUBLICATIONS

- Additional fact sheets in the Nonpoint Pointers series (EPA-841-F-96-004)
- Agriculture and Wetlands: A Compilation of Factsheets (EPA-503/9-92-003)
- Alternative Agriculture, National Research Council, National Academy Press, Washington, DC 1989
- Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Chapter 2 (EPA-840-B-92-002)
- Journal of Soil and Water Conservation, Vol. 45, No. 1, Jan/Feb 1990 (EPA-841-N-90-100)
- Livestock Grazing on Western Riparian Areas, EPA Region 8, Denver, CO
- The Quality of Our Nation's Water: 1994 (EPA-841-S-95-004)
- Soil And Water Quality: An Agenda for Agriculture, National Research Council, National Academy Press, Washington, DC, 1993
- USDA National Resources Inventory, Natural Resources Conservation Service

To order any of the above EPA documents call or fax the National Center for Environmental Publications and Information.

Tel (513) 489-8190

Fax (513) 489-8695

FOR MORE INFORMATION

U.S. Environmental Protection Agency
Nonpoint Source Control Branch
Washington DC 20460

Internet Address:
http://www.epa.gov/owow/nps/index.html

United States Environmental Protection Agency | Office of Water (4606) | EPA 816-F-01-028 July 2001

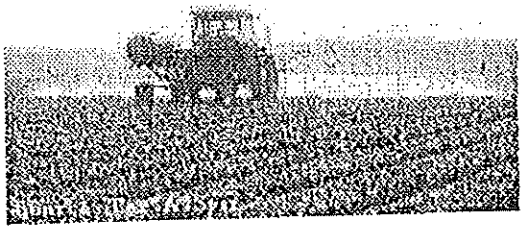
Source Water Protection Practices Bulletin

Managing Agricultural Fertilizer Application to Prevent Contamination of Drinking Water

If improperly managed, elements of fertilizer can move into surface water through field runoff or leach into ground water. The two main components of fertilizer that are of greatest concern to source water quality (ground water and surface water used as public drinking water supplies) are nitrogen (N) and phosphorus (P). This fact sheet focuses on the management of agricultural fertilizer applications; see the fact sheets on managing agricultural pesticide use, animal waste, and storm water runoff for other prevention measures that relate to agriculture.

FERTILIZER USE IN AGRICULTURE

Fertilizer application is required to replace crop land nutrients that have been consumed by previous plant growth. It is essential for economic yields. However, excess fertilizer use and poor application methods can cause fertilizer movement into ground and surface waters. While fertilizer efficiency has increased, Colorado State University estimated that about 25 percent of all preplant nitrogen applied to corn is lost through leaching (entering ground water as nitrate) or denitrification (entering the atmosphere as nitrogen gas).



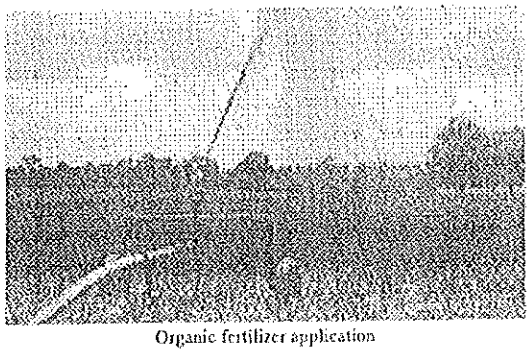
Fertilizer spreading

WHY IS IT IMPORTANT TO MANAGE FERTILIZER USE NEAR THE SOURCES OF YOUR DRINKING WATER?

Improper or excessive use of fertilizer can lead to nitrate pollution of ground or surface water. Nitrogen fertilizer, whether organic or inorganic, is biologically transformed to nitrate that is highly soluble in water. In this soluble form, nitrate can readily be absorbed and used by plants. On the other hand, soluble nitrate is highly mobile and can move with percolating water out of the soil, thus making it unavailable for plant uptakes. Crop producers, therefore, need to match nitrogen applications to crop uptake to minimize nitrate leaching and maximize efficiency.

Use of nitrogen-containing fertilizers can contribute to nitrates in drinking water. Consumption of nitrates can cause methemoglobinemia (blue baby syndrome) in infants, which reduces the ability of the blood to carry oxygen. If left untreated, methemoglobinemia can be fatal for affected infants. Due to this health risk, EPA set a drinking water maximum contaminant level (MCL) of 10 milligrams per liter (mg/l) or parts per million (ppm) for nitrate measured as nitrogen.

Another major component of fertilizer is phosphorus. Under certain conditions phosphorus can be readily transported with the soil. In fact, 60 to 90 percent of phosphorus moves with the soil. Phosphorus is the major source of water quality impairments in lakes nationwide. Even though regulations that affect the taste and odor of water are not Federally enforceable under the Safe Drinking Water Act, municipalities often must treat their drinking water supplies for these aesthetic reasons.


Organic fertilizer application

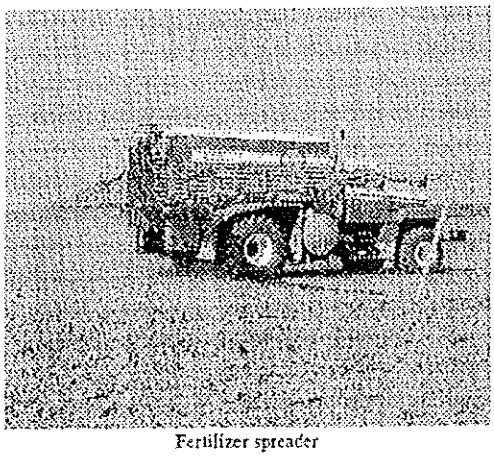
The use of organic nutrient sources, such as manure, can supply all or part of the nitrogen, phosphorus, and potassium needs for crop production. However, organic fertilizers can also cause excessive nutrient loads if improperly applied.

AVAILABLE PREVENTION MEASURES TO ADDRESS AGRICULTURAL APPLICATIONS OF FERTILIZER

This section discusses some of the most often used prevention measures, but is not an exhaustive list of all known measures. For information on additional prevention measures, see the documents referenced in the last section of this fact sheet. Please keep in mind that individual prevention measures may or may not be adequate to prevent contamination of source waters. Most likely, individual measures should be combined in an overall prevention approach that considers the nature of the potential source of contamination, the purpose, cost, operational, and maintenance requirements of the measures, the vulnerability of the source water, the public's acceptance of the measures, and the community's desired degree of risk reduction.

The goal of these prevention measures is to minimize nutrient losses from agricultural lands occurring by edge-of-field runoff and by leaching from the root zone. Effective nutrient management abates nutrient movement by minimizing the quantity of nutrients available for loss. This is achieved by developing a comprehensive nutrient management plan and using only the types and amounts of nutrients necessary to produce the crop, applying nutrients at the proper times and with proper methods, implementing additional farming practices to reduce nutrient losses, and following proper procedures for fertilizer storage and handling.

Application Rates and Fertilizer Types


Fertilizer spreader

One component of a comprehensive nutrient management plan is to determine proper fertilizer application rates. The goal is to limit fertilizer to an amount necessary to achieve a realistic yield goal for the crop. Soil sampling and crediting other sources are also parts of the concept.

Yearly ***soil sampling*** is necessary for determining plant nutrient needs and to make accurate fertilizer recommendations. Many factors must be considered when determining sampling methods and frequency.

Calculating the optimal rate of application also includes ***crediting other sources*** that contribute nitrogen and phosphorous to the soil. Previous legume crops, irrigation water, manure, and organic matter all contribute nitrogen to the soil, while organic matter and manure contribute phosphorus.

Along with soil samples and fertilizer credits from other sources, nitrogen fertilizer recommendations are based on ***yield goals*** established by the crop producers. Yield expectations are established for each crop and field based on soil properties, available moisture, yield history, and management level.

Applying the ***appropriate form of nitrogen fertilizer*** can reduce leaching. Nitrate forms of nitrogen fertilizer are readily available to crops, but are subject to leaching losses. Nitrate fertilizer use should be limited when the leaching potential is moderate to high. In these situations, ammonium nitrogen fertilizers should be used because they are not subject to immediate leaching. However, ammonium nitrogen transforms rapidly into nitrate when soils are warm and moist. More slowly available nitrogen fertilizers should be used in these conditions. Nitrification inhibitors can also delay the conversion of ammonium to nitrate under certain conditions.

Phosphorus fertilizer is less subject to leaching, but loss through surface runoff is more common. To minimize losses of phosphorus fertilizer, applications should only be made when needed (determined through soil testings) and at recommended rates.

Fertilizer Application Timing

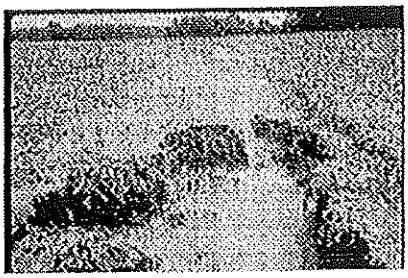
Nitrogen fertilizer ***applications should be timed*** to coincide as closely as possible to the period of maximum crop uptake. Fertilizer applied in the fall has been shown to cause ground water degradation. Partial application of fertilizer in the spring, followed by small additional applications as needed, can improve nitrogen uptake and reduce leaching. Reasons to alter nitrogen amounts include abnormal weather or crop quality.

Fertilizer Application Methods

Fertilizer application equipment should be inspected at least once annually. Application equipment must also be ***properly calibrated*** to insure that the recommended amount of fertilizer is spread.

Correct fertilizer placement in the root zone can greatly enhance plant nutrient uptake and minimize losses. Subsurface applied or incorporated fertilizer should be used instead of a surface broadcast fertilizer. The most efficient application method for many crops, especially in erosive soils, is to place dry fertilizer into the ground in bands. Band or drilled row fertilizers are applied closer to the seed and can be recovered by the crop more efficiently. All surface-applied fertilizers should be mechanically incorporated into the soil to reduce losses through surface runoff and volatilization. Fertilizer should never be applied to frozen ground, and also should be limited on slopes and areas with high runoff or overland flow.

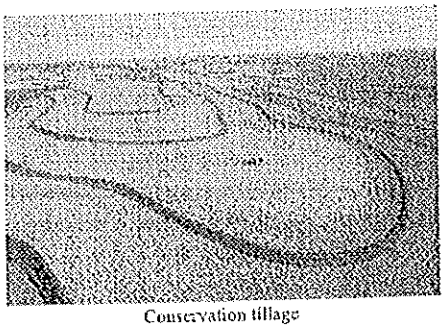
Irrigation water should be managed to maximize efficiency and minimize runoff or leaching. Irrigated crop production has the greatest potential for source water contamination because of the large amount of water applied. Both nitrogen and phosphorus can leach into ground water or run off into surface water when excess water is applied to fields. Irrigation systems, such as sprinklers, low-energy precision applications, surges, and drips, allow producers to apply water uniformly and with great efficiency. Efficiency can also be improved by using delivery systems such as lined ditches and gated pipe, as well as reuse systems such as field drainage recovery ponds that efficiently capture sediment and nutrients. Gravity-controlled irrigation or furrow runs should be shortened to prevent over-watering at the top of the furrow before the lower end is adequately watered.



Runoff

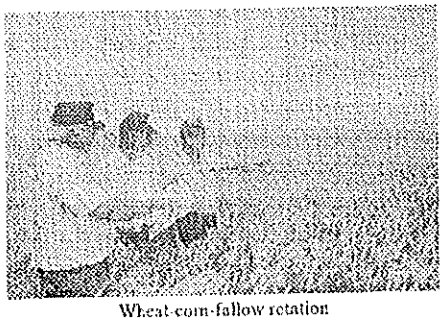
Additional Farming Practices

A complete system is needed to reduce fertilizer loss. Components of this system often include farming practices that are not strictly related to fertilizer, such as conservation tillage and buffers.


Conservation tillage

Conservation tillage is another field management method used to reduce runoff. In conservation tillage, crops are grown with minimal cultivation of the soil. When the amount of tillage is reduced, the plant residues are not completely incorporated and most or all remain on top of the soil. This practice is critical to reducing phosphorus losses because the residue provides cover and thereby reduces nutrient runoff and erosion by water.

Creating ***buffer strips or filter strips*** can impede runoff and help filter nitrogen and phosphorus from runoff. Buffer strips and filter strips are created by planting dense vegetation near surface water bodies. The root systems of these plants hold soil in place, thereby decreasing the velocity of runoff and preventing erosion. The vegetation and soils strain and filter sediments and chemicals. For more information on buffer strips and filter strips see the fact sheet on storm water runoff.


Wheat-corn-fallow rotation

Crop rotation can often yield crop improvement and economic benefits by minimizing fertilizer and pesticide needs. Planting legumes as part of a crop rotation plan provides nitrogen for subsequent crops. Deep-rooted crops can be used to scavenge nitrogen left in the soil by shallow-rooted crops. *Cover crops* stop wind and water erosion, and can use residual nitrogen in the soil.

A high-tech way to level or grade a field is to use ***laser-controlled land leveling*** equipment. Field leveling helps to control water advance and improve uniformity of soil saturation in gravity-flow irrigation systems. This improves irrigation efficiency and reduces the potential for nutrient pollution through runoff.

Fertilizer Storage and Handling

Follow label directions for storing and mixing fertilizer and for disposing empty containers. Lock or secure storage container valves when the container is not in use.

Protect permanent fertilizer storage and mixing sites from spills, leaks, or storm water infiltration. Storage buildings should have impermeable floors and be securely locked. Impermeable secondary containment dikes can also be used to contain liquid spills or leaks. Do not store fertilizer in underground containers or pits.

To prevent accidental contamination of water supplies, mix, handle, and store fertilizer away from wellheads and surface water bodies. Installing anti-backflow devices on equipment can also prevent spillage. Ideally, mix and load fertilizers at the application spot.

Immediately recover and reuse or properly dispose of spills. Granular absorbent material can be used at the mixing site to clean up small liquid spills.

FOR ADDITIONAL INFORMATION

These references have information on agricultural fertilizer use and best management practices. All of the following documents are available for free on the internet. You should also contact the U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS), Conservation District, and Agricultural Extension Service representatives in your area for more information on nutrient management and cost-share programs, such as the Environmental Quality Incentives Program (EQIP), the Conservation Reserve Program (CRP), and the Conservation Reserve Enhancement Program (CREP), to assist in financing source water protection measures.

Contact local government authorities in your area to see if there are ordinances in place to manage fertilizer use. Numerous examples of local source water protection-related ordinances for various potential contaminant sources can be found at:
http://www.epa.gov/r5water/ordcom/
http://www.epa.gov/owow/nps/ordinance/
http://www.epa.gov/owow/nps/ordinance/links.htm

The following documents provide more detailed information on prevention measures for fertilizer use on the farm.

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U.S. Department of Agriculture, Natural Resources Conservation Service. *Conservation Practices Training Guide.* (1999, August). Retrieved April 30, 2001 from the World Wide Web: http://www.ftw.nrcs.usda.gov/tech_ref.html

Virginia Cooperative Extension. *Fertilizer Storage, Handling, and Management* (442-906). (1996, June). Retrieved February 9, 2001 from the World Wide Web: http://www.ext.vt.edu/pubs/farmasyst/442-906/442-906.html

United States Environmental Protection Agency

Office of Water (4606)

EPA 816-F-01-031
July 2001

Source Water Protection Practices Bulletin

Managing Small-Scale Application of Pesticides to Prevent Contamination of Drinking Water

Pesticides (including insecticides, herbicides, and fungicides) contain a variety of chemicals used to control pests, insects, and weeds. They are used in many applications to reduce the damage to plants by insects and other pests, and to control overgrowth of undesirable plant species. This fact sheet describes measures to prevent contamination of drinking water sources from small-scale pesticide application (i.e., on lawns, golf courses, cemeteries, parks, and roadways); see also the fact sheet on prevention measures for large-scale pesticide application for agricultural or farm conditions.

SOURCES OF PESTICIDES

Pesticides are used in a variety of applications in areas with green spaces. They are used by homeowners, in commercial establishments such as golf courses and cemeteries, and along roadways. Homeowners use pesticides in lawn care and gardening activities. Many homeowners plant non-native plant species, which require pesticides, fertilizers, and watering to keep them healthy.

Golf courses and recreational areas such as parks and other open spaces use pesticides for similar purposes. Shorter grasses typical of golf courses are less resistant to insects and require application of pesticides to keep them healthy. Pesticides are also used to maintain lawns in cemeteries and commercial areas. Herbicides are used along roadways and transportation and utility corridors to limit vegetation growth and increase visibility for drivers or access to power lines.

Excess rain can wash pesticides from plants and soil. This can, in turn, run off into streams. Pesticides can leach into the soil if plants are watered or rainfall occurs soon after application. Some pesticides resist degradation by microbes in the soil and will eventually leach into the ground water. Pesticides can reach ground water through drains, sink holes, and other conduits as well.

WHY IS IT IMPORTANT TO MANAGE SMALL SCALE APPLICATION OF PESTICIDES NEAR THE SOURCES OF YOUR DRINKING WATER?

Pesticides contain a variety of organic and inorganic compounds. By nature, they are poisonous, and while they can be safely used if manufacturers' usage directions are followed, they can, if

mismanaged, seep into surface water and ground water supplies. They can be difficult and expensive to remove, and, if inhaled or consumed, be hazardous to human health. The synthetic organic chemicals in pesticides have been linked to serious health problems, including cancer, liver and kidney damage, reproductive difficulties, and nervous system effects.

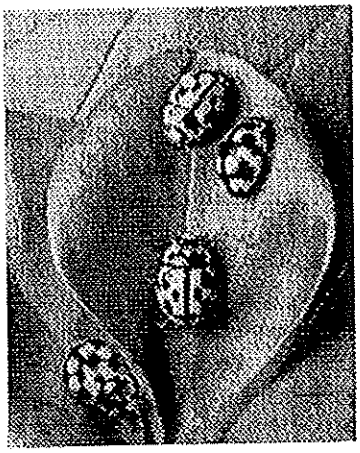
Once a water supply becomes contaminated with a pesticide, it can be very difficult and costly to treat. Treating the water supply is a lengthy process and is not always successful. Using an alternative water source may also be costly and impractical. For example, it would be very expensive to connect to another public water system, and drilling new wells does not necessarily guarantee that the new ground water source will not be contaminated.

AVAILABLE PREVENTION MEASURES TO ADDRESS SMALL-SCALE PESTICIDE APPLICATION

Prevention measures are available to protect source water from pesticide contamination. They range from simple, common-sense activities (e.g., reading the label) to more complex activities such as properly storing and disposing pesticides. Most prevention measures for small-scale application of pesticides tend to be easy, low cost activities. The most effective pesticide contamination prevention measures encompass both simple and complex practices to reduce the potential for pesticides to move into source water. Prevention measures can be divided into those that protect surface water from pesticide runoff and those that protect ground water from leaching or percolation.

Please keep in mind that individual prevention measures may or may not be adequate to prevent contamination of source waters. Most likely, individual measures should be combined in an overall prevention approach that considers the nature of the potential source of contamination, the purpose, cost, operational, and maintenance requirements of the measures, the vulnerability of the source waters, the public's acceptance of the measures, and the community's desired degree of risk reduction. The following are the more conventional prevention measures used to avoid contamination from small-scale application.

There are many options available to minimize the need for pesticides. ***Integrated Pest Management (IPM)*** is the use of all means of pest control (chemical and non-chemical) in a compatible fashion to reduce pesticide use. Pesticides are the last line of defense and are used only when pest levels are causing sufficient damage to offset the expense of the application. IPM includes ***regular monitoring*** to check levels of pest populations and their damage to determine management needs, be it pesticide application or other management actions. Monitoring can be accomplished by a trained employee such as a facility manager. IPM also includes ***non-chemical control measures*** such as mechanical, cultural and biological controls, sanitation, and pesticide-resistant plants are highly recommended. Where possible ***alternate plants,*** select ***pest-resistant plant varieties,*** and mulch the gardens or flower beds to reduce weeds. Maximize the benefits of naturally occurring ***biological controls*** by using pesticides only when necessary. Many insecticides are broad spectrum materials and affect beneficial insects and other arthropods as well as pests. If pesticides must be used, select those that are designed specifically for the pests you wish to control, and are ***low-persistent*** in the environment.



Ladybugs are a natural control for aphids

Proper Pesticide Application

Reading the label on the pesticide container is one of the simplest and most important prevention measures. The label indicates the proper use, rate of application, whether the pesticide is broad spectrum or selective (i.e., kills everything or only a certain type of insect), and proper handling of the pesticide. The label also provides information on proper storage and disposal, and emergency contact numbers, if accidentally ingested. In cases where the pesticide is highly toxic, the label will contain special warnings and use restrictions, such as *setbacks* for mixing and application away from wells or drinking water sources. Reading the label and following the directions will ensure that pesticides are *not over-used* and are used in a way that is *consistent* with the pest problem.

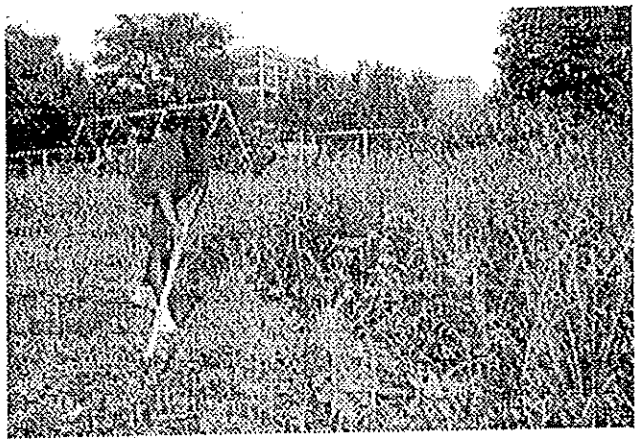
Proper application of pesticides reduces the amount of chemicals applied to the ground and saves landowners money by reducing the amount of pesticides purchased. Calibrate application equipment to allow correct application, follow pesticide manufacturers' directions, and select leaching-resistant or "slow release" pesticides. Apply in large droplets to resist carrying away by the wind. Mix and load pesticides only over impervious surfaces, such as cement, that do not contain floor drains or storm water drain inlets; these drains may convey spills to ground water sources. Check the pesticide label for pesticide application procedures; do not over-apply the pesticide.

Pesticides should not be applied immediately before or after rainfall, as this may cause soil runoff at the application site and the need to reapply the pesticide. The soil in the runoff can carry the pesticide to the local storm water drain, and contaminate local source waters.

Ways to Reduce Pesticide Use

Select healthy seeds and seedlings that are known to resist diseases and are suited to the climate. Strong seeds are likely to produce mature plants with little need for pesticides. Planting pest-resistant plant varieties and local plant species will also reduce pesticide needs.

Alternate your plants each year; plants will not be vulnerable to the pests that survive the winter. Insects will move to another location where they can find nutrients, and weeds will remain dormant until their nutrient source is replenished.



Manual activities such as spading, hoeing, hand-picking weeds and pests, setting traps, and mulching are all good ways to get rid of pests without using pesticides. Homeowners have a tendency to over-use pesticides, and should take care to use only what they need.

Proper *plant management* can improve plant health, reduce the need for pesticides, and reduce runoff and infiltration. Use mowing and watering techniques that maintain a healthy lawn and minimize the need for chemical treatment. Maintain proper drainage and aeration to encourage the growth of microbes that can degrade pesticides. Reduce watering to control seepage of pesticides to the ground water; this conserves water and reduces runoff.

Use of ***biological controls*** reduces the need for chemical pesticides. Plants that attract predatory species, such as birds and bats, can enhance landscaping and naturally reduce pests.

Proper Pesticide Storage and Handling

Proper storage is important in preventing both surface water and ground water contamination. Store pesticides in intact containers in a shed or covered structure on an impermeable surface such as concrete. You must follow directions for storage on pesticide labels, although the directions are usually general, such as "Do not contaminate water, food, or feed by storage or disposal." Do not store pesticides in areas prone to flooding. Keep pesticides in their original containers; if the label is unreadable, properly dispose of the product.

Spill clean up is another important prevention measure. Promptly sweep up dry spills and reuse the pesticides as intended; dry spills are usually easier to clean. For liquid spills, recover as much of the spill as possible and reuse it as intended. It may be necessary to remove some contaminated soil. Have cat litter or other absorptive materials available to absorb unrecovered liquid from the floor. Be sure to have an emergency contact number to call for help, if necessary. Be sure to check the label for proper handling of the chemicals.

Disposal of pesticide containers can lead to ground water contamination if the containers are not stored or cleaned properly. Chemical residues from these containers can leak onto the ground. Homeowners and other users may have smaller quantities of pesticides and empty containers and different disposal options than farmers.

Homeowners usually use nonreturnable containers, and have the option of participating in their local community household hazardous waste collection events. Partially-full and empty containers may be given to household hazardous waste collection. Homeowners should only triple rinse pesticide containers if they are able to use the rinse water immediately, e.g., on plants that require pesticides. Rinse water should never be disposed down a drain or into a sewer system. Recycle plastic and metal containers whenever possible, keeping in mind that non-hazardous container recycling programs may refuse to take pesticide containers. Empty containers may be disposed in regular trash. Shake out bags, bind or wrap them to minimize dust, and put them in regular trash. Do not bury or burn pesticide containers or bags on private property. Homeowners may give unused pesticides to a neighbor rather than throw them away.

Farmers and users of larger quantities of pesticides (e.g., golf course managers) may have larger quantities of pesticides to store and dispose, and are often prohibited from participating in community household hazardous waste collection events. To prevent ground water contamination, use returnable containers as often as possible and take them back to the dealer. For non-returnable containers, pressure-rinse or triple-rinse containers immediately after they are empty, since residue can be difficult to remove after it dries, and apply the rinse water appropriately (i.e., on plants that require pesticides). Most States have collection programs for farmers and other pesticide users with unwanted pesticides, often referred to as Clean Sweep programs. Many States also have pesticide container and recycling programs. Puncture nonreturnable containers and store them in a covered area until they can be disposed according to your State's guidelines. Shake out bags, bind or wrap them to minimize dust, and take them to a permitted landfill. Do not bury or burn pesticide containers or bags on private property. Contact your State Department of Agriculture or Department of Environmental Quality for information. If containers are full or partially full and the pesticide is in good condition, it may be given to another pesticide user. However, if the pesticide is labeled a restricted use pesticide, it can only be distributed and used by certified applicators.

FOR ADDITIONAL INFORMATION

These sources contain information on pesticide management measures. All of the documents listed are available for free on the Internet. Contact local government authorities in your area to see if there are ordinances in place to manage pesticides.

AgSafe Coalition. *Safely Handling Pesticides.* Retrieved February 15, 2001, from the World Wide Web: http://www.agsafe.org/series_1/pesticide.html.

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Massachusetts Department of Food and Agriculture, Pesticide Bureau. *A Homeowner's Guide to Environmentally Sound Lawncare.* Retrieved June 4, 2001, from the World Wide Web: http://www.massdfa.org/pesticides/publications/homeowner.htm

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National Pesticides Telecommunications Network. *Pesticide Fact Sheets.* Retrieved June 4, 2001, from the World Wide Web: http://nptn.orst.edu/nptnfact.htm

Natural Resources Defense Council. *Pesticide Exposure and Toxicity to Infants and Children.* March 1998. http://www.nrdc.org/health/kids/edw0398.asp.

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Pesticide Watch. *Pesticides and Human Health.* Retrieved March 12, 2001, from the World Wide Web: http://www.pesticidewatch.org/Html/PestProblem/HumanHealth.htm.

Schueler, Thomas R. and Heather K. Holland. "Toward a Low-Input Lawn." *The Practice of Watershed Protection: Techniques for protecting our nation's streams, lakes, rivers and estuaries* 2(1): 254-264.

The Northwest Coalition for Alternatives to Pesticides. *Alternatives Fact Sheets.* Retrieved January 24, 2001, from the World Wide Web: http://www.pesticide.org/factsheets.html#alternatives.

Toxic Alert. *Poison In The Grass: The Hazards And Consequences Of Lawn Pesticides.* Retrieved March 12, 2001, from the World Wide Web: http://www.eqs.com/elawn.htm.

United States Environmental Protection Agency, Office of Environmental Health Hazard Assessment. *Pesticide Programs.* Retrieved January 23, 2001, from the World Wide Web: http://www.oehha.ca.gov/pesticides/programs/index.html.

U.S. EPA, Office of Prevention, Pesticides, and Toxic Substances. *Healthy Lawn, Healthy Environment - Caring for Your Lawn in an Environmentally Friendly Way.* 700-K-92-005. June 1992. Retrieved January 24, 2001, from the World Wide Web: http://www.epa.gov/oppfead1/Publications/lawncare.pdf.

U.S. EPA, Office of Prevention, Pesticides, and Toxic Substances. *Citizen's Guide to Pest Control and Pesticide Safety.* Retrieved January 24, 2001, from the World Wide Web: http://www.epa.gov/OPPTpubs/Cit_Guide/citguide.pdf.

United States Geological Survey, National Water Quality Assessment Pesticide National Synthesis Project. *Pesticides in Ground Water.* Retrieved January 23,2001, from the World Wide Web: http://water.wr.usgs.gov/pnsp/gw/index.html.